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Assessment of Technological Systems

NATO Committee on the Challenges of
Modern Society, Brussels (Belgium)

Prepared for

Environmental Protection Agency
Washington, DC

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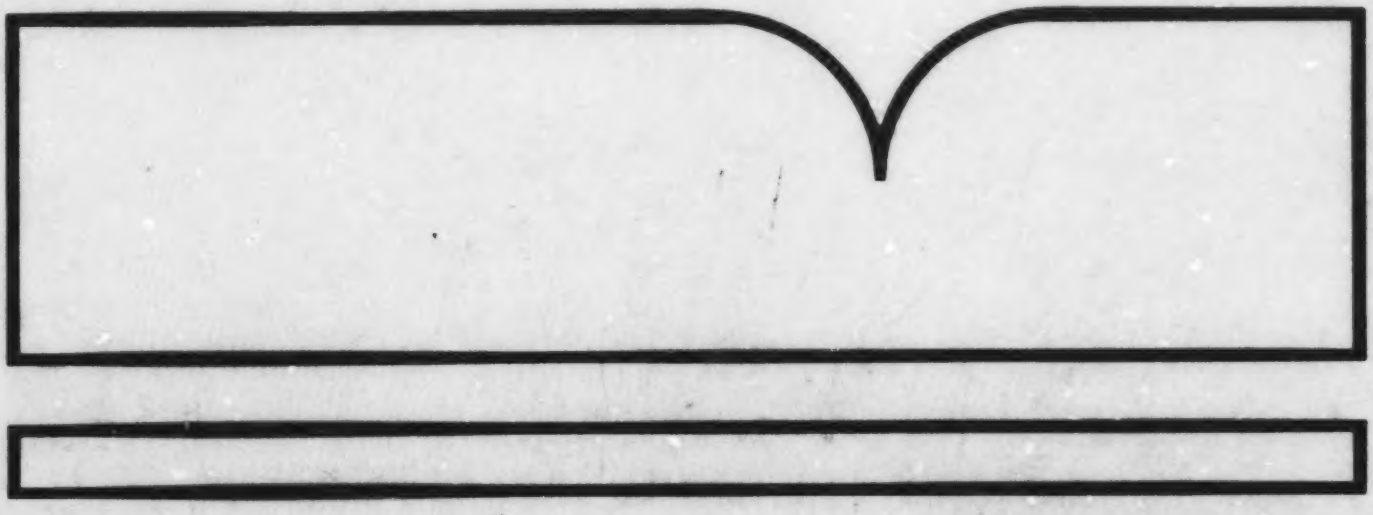

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NORTH ATLANTIC TREATY ORGANIZATION
COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY

Assessment of Technological Systems

CCMS Report No. 115

Rapport CDSM No. 115

Evaluation des Systèmes Technologiques

COMITE SUR LES DEFIS DE LA SOCIETE MODERNE
ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

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Proceedings of the CCMS Round Table Discussion
5th-6th May, 1980, in Brussels

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EVALUATION DES SYSTEMES TECHNOLOGIQUES

Compte-rendu des débats de la table ronde du CDSM
des 5 et 6 mai 1980 à Bruxelles

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PART I

PREPARED STATEMENTS

Note: Statements are in the language and order in which they were made

*

PARTIE I

PRESENTATIONS

Note: Les présentations suivantes sont dans la langue et dans l'ordre dans lesquels elles ont été faites

Acting Secretary General
Mr. R. Petrignani

Secrétaire général ad intérim
M. R. Petrignani

I have pleasure in welcoming you to the 22nd Plenary Session of the Committee on the Challenges of Modern Society. In the absence of the Secretary General, who is in North America, I am personally gratified at this opportunity to associate myself for the first time with the work of the Committee.

To those of you who may be attending a meeting of the Committee for the first time, I extend a special welcome. I am sure that you will find this meeting both informative and rewarding.

The period since the Committee last met in Brussels twelve months ago has been a particularly active one. I am referring not only to your Tenth Anniversary celebrations which took place last October - very appropriately in Washington, the city of the Committee's conception. But, in the more substantive field, I note that the number of pilot studies currently in progress is higher than ever before in the Committee's history; an interesting proposal for an addition to the list of studies is included in the agenda for this meeting. Then, in the past few months, you have taken steps to streamline your administrative procedures. All this against a background of continuous, expert work, as exemplified by your agenda items dealing with a symposium on the disposal of hazardous wastes and a conference on the management of technology.

The large number of pilot studies currently in progress and the growing number of nations taking the lead in these studies testify to the value attached to the Committee by the governments of the Alliance. The significance of the Committee's achievements is equally attested in the international field by the growing interest in its work in areas far beyond the boundaries of NATO. Demand for the published results of pilot studies - a series of publications which is now running in three figures - is increasing to the point where we may shortly be faced with a decision on whether reprints will be required.

I observe that the principal item on your agenda is a review and assessment of technological systems. If you will permit some remarks from a layman, it seems to me that this question is likely to assume increasing importance as time goes on if Man is to manage and guide his technology and not be a prisoner of it. We must do more to ensure a more humane and rational future by making intelligent choices with respect to the potential economic, political and social impacts of technology and change.

It goes without saying that the assessment of future developments is no easy task. In the closing years of the Nineteenth Century, that great physicist, Lord Kelvin, made the following three predictions:

- X-rays will prove to be a hoax,
- aircraft flight is impossible, and
- radio has no future.

Nor was he the only technological pessimist that led Arthur C. Clarke to remark in his book "Profiles of the Future" that "when a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is almost certainly wrong".

I cannot deny the complexity of the problems inherent in attempting to predict what technology holds in store for our society. A few years ago, OECD's report on Science, Growth and Society wisely pointed out that it might appear sometimes, when the stable equilibrium of society is compromised, that not every innovation is desirable, and that not every desirable innovation spontaneously appears when needed: the random aspect of technological progress seems to threaten man's social and natural environment. It is not, however, technology itself that is to blame for these disruptions, but the manner in which society applies and diffuses it, in view of the impossibility of planning innovation. Change cannot be left to follow the logic of technology alone; society must adapt itself, both to moderate innovation according to needs and to avoid undesirable side-effects.

Modern industrial societies, beset by harsh social and economic difficulties, by increasingly rapid change and by a feeling of growing complexity, have come to attribute their problems to the spontaneous and unbridled character of technological progress. They have thus sought to gain greater social control over the processes of decision on research, technological innovation, and the social and economic equilibria.

It seems to me that the function of any control mechanism would be to forecast the range of possible effects of technology on society and the natural environment, so as to illuminate society's choices before options are foreclosed by default. It would also be required to explore the new possibilities of satisfying social and economic needs afforded by scientific progress. Finally, it would keep a watch on the evolution of these needs with a view to redefining its aims and refining the goals of society in the light of new knowledge.

Aucune de ces tâches n'est entièrement nouvelle. Certaines formes d'évaluation technologique - par exemple l'inspection à laquelle sont soumis les nouveaux produits alimentaires et pharmaceutiques - existent depuis longtemps. Ce qui est nouveau c'est l'importance et la complexité croissantes du processus. Lorsque je considère les problèmes auquels nous nous trouvons aujourd'hui confrontés, je m'aperçois que cette complexité croissante est presque devenue une nouvelle dimension politique. C'est le problème de l'interface: la prise en compte d'une multitude d'objectifs de manière à influencer l'élaboration de politiques adaptées aux sociétés modernes et à leurs libres institutions. Malheureusement, ni la structure, ni les pouvoirs de la plupart de nos institutions internationales ne leur permettent de faire face à cette situation.

A ce sujet, permettez-moi de rappeler une fois encore le concept si fécond des trois générations de la politique de l'environnement exposé pour la première fois par le représentant du Canada lors de votre réunion de Düsseldorf de 1977, concept qui a été par la suite étendu aux systèmes alimentaires et énergétiques. C'est un exemple parfait du type de problème auquel nous sommes confrontés et du piège dans lequel nous risquons de tomber.

Comme vous le savez, la première génération concernait l'élimination de la pollution, la deuxième la gestion de l'énergie et des ressources, et la troisième les principes fondamentaux d'une protection à long terme de l'environnement et l'élaboration d'une éthique de la conservation.

Quelles que soient les raisons, politiques ou autres, qui nous incitent à accorder davantage d'intérêt à l'un ou l'autre de ces problèmes, nous devons concentrer nos efforts en même temps sur les trois aspects de cette politique, car il faut admettre que la conservation des systèmes de la biosphère doit être au centre de nos préoccupations.

Quelle que soit l'urgence de nos autres problèmes, nous ne devons pas perdre de vue le fait que cette troisième génération doit être intégrée aux autres grands domaines de l'activité humaine et que notre but final doit être de faire admettre que cette exigence est un principe fondamental des politiques nationales et internationales, au même titre que les autres grands impératifs de notre temps. Et pourtant, nous ne savons comment réaliser une telle intégration, spécialement en ce qui concerne le fondement de la politique de l'environnement et nous continuons à nous intéresser plutôt aux symptomes qu'à la maladie.

Etant donné l'efficacité particulière de votre Comité, je suis sûr que vous parviendrez, comme d'habitude, à élaborer une approche pragmatique pour que les décideurs soient informés de ces préoccupations aux premiers stades du processus de planification afin qu'elles puissent infléchir ce processus, et j'espère également que vous parviendrez à élaborer des mécanismes permettant d'assurer l'efficacité de ces interventions. J'estime que l'étude des problèmes relatifs à l'évaluation de la technologie qui est l'objet de vos discussions aujourd'hui, est particulièrement opportune. Toutefois, il s'agit d'un problème beaucoup trop important pour qu'on en reste là. Il mérite mieux que de simples discussions, quel qu'en soit l'intérêt. J'espère que dans un souci d'efficacité votre table ronde ne s'intéressera pas seulement aux principes, mais qu'elle s'attachera à promouvoir des politiques nationales grâce à des études pilotes appropriées, voie dans laquelle vous avez su faire oeuvre de pionnier.

Acting Assistant Secretary
General for Scientific and
Environmental Affairs

Secrétaire général adjoint
ad intérim pour les affaires
scientifiques et l'environnement

Dr. P.W. Hemily

Round Table discussions during CCMS Plenary Meetings have provided useful occasions to exchange views on common policy concerns. The use, developement and control of technology has been at the forefront of our past Round Table discussions, and indeed has been the basis of the pilot country studies aimed at sharing experience and providing guidance for dealing with pragmatic challenging technical problems facing our modern societies. Following up our most valuable discussions at previous Plenary Meetings on the preparation of environmental impact assessments, the enhancement of urban development, and the assessment of our pilot studies on energy problems, your Coordinators and ad hoc groups have considered further CCMS attention might be devoted to questions concerning the development of suitable technology and public participation in the planning of technical innovation. This Round Table discussion on the Review and Assessment of Technological Systems highlights this serious preoccupation of the Committee.

In the sense of managing technical problems more effectively, CCMS work has certainly been focused on assessing the implications of technological developments. But what may be perhaps a new element in our considerations is the need to give added impetus to take more seriously into account the secondary and higher order effects of technological developments on the whole host of societal concerns.

Economic development, defence posture, our national political decision-making as well as international political relationships, our standard of living as well as the problems of environmental pollution, urban congestion, our concerns over the uncertain provision of energy resources, are all clearly and predominantly driven by technological change. Within this perspective it would be important to be able to assess the implications of potential technological developments not only to see what is economically feasible but also what is socially acceptable and beneficial.

Mr. Petrignani highlighted the growing importance as well as the complexity of attempting to predict what technology holds for society. He drew on significant OECD examination of these issues some 10 years ago - that change cannot be left to follow the logic of technology alone; that society must adapt itself, both to moderate innovations according to needs and to avoid undesirable side effects. He noted that we have serious problems of sometimes conflicting social and economic objectives. Still, it is the forward thinking of CCMS on the management of technology broadly conceived that should provide the underlying basis for its future work. We may be better able to foresee and deal with the causes of problems rather than continue to contend with the symptoms of problems.

This Round Table discussion will provide an opportunity to exchange views on some 15 years' experience on the use of technology assessment. We know that some of our countries are unsure about the value of technology assessment as a general concept - there are conceptual problems on rationalizing quantitative and qualitative factors and serious concerns of putting science and technology on trial, so to speak, in contrast to just clarifying issues and options for decision makers. We have the good fortune of a provocative United States paper(1) before us covering perspectives on the use of technology assessment in the United States - it concludes with a section listing possible questions or issues for the Round Table discussion.

Finally, I wish to note the considerable effort and experience of other international bodies in tackling the issues involved in the management and control of technology and particularly technology assessment - the European Communities, the Organization for Economic Cooperation and Development, the Scientific and Technical Committee of the North Atlantic Assembly and the NATO Science Committee. We may have opportunity to refer to these achievements in our discussions.

I suggest we proceed with the presentation of statements from national delegations.

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(1) See Appendix

UNITED STATES ETATS-UNIS

Mr. Steven E. Plotkin, Office of Technology Assessment,
United States Congress

Since the start of the Industrial Revolution, it has become increasingly apparent that the introduction of a new technology, aside from producing the direct benefits claimed by its promoters, will often also create unintended side effects which may be so detrimental as to offset their intended benefits. Technological and societal change have of course interacted with each other subtly since the beginning of civilization. However, in the last few centuries, the accelerating rate of change in technology has made these unwanted effects much more apparent.

A good example of a technology with severe side effects is the automobile, which was introduced as the solution to the odour and health problems associated with horse-drawn transportation. These problems were by no means insignificant. However, the automobile has led to massive air pollution, tens of thousands of fatalities each year from accidents, and radical transformation of the way we live and work. Other prominent examples of technologies that have radically changed society or had severe and unforeseen impacts include a whole range of agricultural technologies such as mechanized harvesting equipment, high-yield grains and pesticides. The advent of mechanised harvesting had an enormous impact on the labour requirements of agriculture, and in the U.S. was a major factor in a radical shift of population from South to North and from rural areas to the cities. High yield grains, although they have produced undoubted benefits, may have a serious impact on the survival of the diverse gene pool of grains. The environmental impacts of heavy uses of pesticides needs no elaboration.

In each of these cases, the technology was introduced without taking a broad look at all its implications. The usual pattern in such cases has been for governments, given sufficient popular public pressure, to react to emerging impacts by taking steps to mitigate the effects after the fact. A substantial portion of United States regulatory law concerns precisely this problem of controlling the adverse impacts of technology. However, a basic drawback of this approach is that it can treat the symptoms but rarely can cure the underlying problems. The basic infrastructure of a technology is in place and the best we can hope for at this time is to modify it. Radical changes usually are too expensive, especially in the short term. Growing public concern, as expressed through the environmental and consumer movements of the 1960s and 1970s in the United States, has created the view that government and industry must do better than simply responding after the damage is done. In some cases, we are faced with such severe public hostility to new technology that we have the choice of either managing it properly or running a substantial risk of our citizens becoming basically

anti-technology in ideology. This situation has stimulated the development of various techniques and analytical tools for systematically forecasting and analyzing the possible side effects of technology. This is the first step in the intelligent management of technology. The combination of these tools into a coherent framework for analyzing technology is often referred to as technology assessment, or TA. The methods of technology assessment have not yet reached final form - and they may never do so. The technique is still evolving but in general it involves convening an interdisciplinary team to anticipate, identify and evaluate the potential impacts or consequences of a technology on society. TA must go beyond the standard questions of technical feasibility, direct costs, and safety and instead, must focus on the unplanned impacts and consequences of a technology.

In the United States, at least sixty offices and agencies of the federal government have been involved in technology assessments. The leading agencies conducting assessments are my own Office of Technology Assessment, which is a staff agency of the United States Congress, and the National Science Foundation.

OTA provides the legislative branch of government with an independent capability to conduct assessments of technology. These assessments explicitly analyse a range of policy options that Congress may consider in addressing the issues raised by the analysis of impacts. The analysis also attempts to reveal the potential impacts of pursuing each of these options. The office has a permanent staff of about eighty to ninety professionals supplemented by consultants and outside advisors.

The National Science Foundation is an executive branch agency with the mission of promoting American science. It has no direct regulatory responsibilities, but performs TAs on a wide range of issues. Unlike the OTA, NSF does not conduct assessments using its own employees, but contracts with universities, private industry, and individual consultants to perform them.

Other agencies with smaller but still quite significant TA programmes are the Environmental Protection Agency, which has created an integrated assessment programme to look at large energy systems such as energy development in the western United States, in the Ohio River Basin, and the Texas lignite fields, and also the Department of Energy, which also carries out similar assessments, using the National Laboratories.

Technology assessment is also carried out in the private sector both in response to government actions and on independent activities. As I note in my complete paper(1), many major U.S. corporations conduct technology assessment. This leads us to the question of whether or not all this activity in TA is actually leading to better management of technology. Are these assessments affecting policy-makers?

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(1) See Appendix

It is rare to find a situation where technology assessment has been unambiguously responsible for a major policy decision. For example, even the most formal role assigned to technology assessment, the environmental impact statement, while mandated by law for each major federal action in the U.S., does not bind agency decision makers. I think, however, that you can say the same for any type of analysis, given the very complex - even convoluted - nature of policy-making in the U.S. There is a general sense, however, that in many cases the findings of a technology assessment have been quite influential in reaching final decisions. For example, the process of developing environmental assessments has often indicated necessary changes to make a project environmentally acceptable or in some cases has led to the abandonment of poorly conceived projects and I give some other examples in the complete paper.

A decade of experience in the United States with technology assessment has produced several insights into the problem of applying TA. First of all, uniform measures of impact must be used with caution. While having all factors reduced to a simple set of cost/benefit numbers would vastly simplify the decision-making process, there are many methodological as well as policy problems in reducing many impacts to simple numbers. Were we able to completely quantify our assessments, we would eliminate the need for politicians who fund assessments; there could then be no assessments. Natural law, therefore, forbids quantification of impacts into a single measure. A valid technology assessment therefore represents a balance between quantitative analysis and judgment. The proper balance varies with the individual circumstances of each TA. Second, in some cases, a TA might be viewed as a failure because it could not resolve a major confrontation over the development of a particular technology. However, while TA cannot pass final judgment on a technology, it can be invaluable in identifying modifications to avert adverse impacts or alternatives which might be more beneficial. In many cases, a TA has been most valuable in creating a pool of experts who can advise policy makers or even assist in managing the technology.

A TA team must be selected and organized so that the members can interact with each other effectively rather than working in isolation. Because of the need for the inter-disciplinary nature of the analysis and the need for team members to be constantly reviewing and challenging their colleagues' work, individuals who are accustomed to working in hierarchical, competitive organizations oriented towards disciplinary research may not be satisfactory TA team members. Also, the need to maintain objectivity and credibility may conflict with the need to obtain certain kinds of specialized expertise because the experts may have preconceived opinions about the technology being analysed.

A technology assessment is also most effective when it takes into account the views and concerns of all parties who may be affected by the introduction of the technology. This helps both by increasing and perceived - and the actual - objectivity of the analysis as well as by providing insights which might not otherwise be gained by a more limited group of participants. This approach also forces the TA team to translate their information into a form suitable for non-experts. This is a short-term cost, but it is also a tremendous benefit

to the possibilities of the eventual acceptance of the TA results by the public.

Finally, the credibility of technology assessment depends not only on its content but also on the organization sponsoring it. Several quite worthwhile technology assessments have been viewed with suspicion because they were prepared by such agencies as the Atomic Energy Commission, or others which have been viewed as being inherently biased by certain segments of the population. Therefore it might be most useful for the credibility of a TA to assign its preparation to an independent government agency or to a university or respected research institution.

Several points which could be useful for discussion at this Round Table arising from the review of technology assessment include such questions as:

(1) To what extent is anyone responsible for anticipating and taking steps to prevent adverse impacts of technology? And here I think the argument centres round whether it should be government or private industry which takes that responsibility.

(2) What are the relative roles of government and of industry?

(3) What is the criteria to be used to decide if government should favour a technology with positive impacts by seeking to eliminate economic or non-technical barriers to its introduction?

(4) What is the most useful role for technology assessment in the public decision-making process?

(5) How can the concerns of local interested parties be best included in the assessment?

(6) How can the credibility and objectivity of a technological assessment be preserved while at the same time ensuring an adequate level of expert analysis?

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The Honorable William J. Beckham, Deputy Secretary, Department of Transportation

I would like to make just a couple of observations about our experiences in the Department of Transportation with the evaluation and assessment of technology.

In the field of transportation, we have often been presented with fairly exotic technological approaches to a number of problems. As a rule, these approaches require substantial amounts of development money and, frequently, significant environmental questions are raised. More than once, indeed, we have been confronted with a proposal for a technologically impressive piece of machinery, but no real-world problem that it really fits. I am sure that everyone else here has had similar experiences.

In any event, the Department of Transportation has had to carry out a number of exercises in the evaluation of proposed new technologies. Not all of these exercises have been of the far-ranging environmental character of the approach described in the paper prepared by the Office of Technology Assessment. Some of these analyses have been more narrowly focussedon the economic characteristics of the device in question and its immediate environmental impacts. Included in this group have been studies of short takeoff and landing (STOL) aircraft, track levitated vehicles (TLV) and a variety of automated mass transit systems. We have also undertaken more broad ranging environmental assessments, especially in connection with the effect of aircraft operations on the upper atmosphere.

Some of these efforts have come to strongly negative findings. For both economic and environmental reasons, we found it was a poor idea to try to develop commercial aircraft for operation out of very short (less than 2500 feet) landing fields in or near center city areas. We also found that the use of high-speed trains to be suspended over a guideway by means of either an air cushion or a magnetic field to be economically unsound.

In urban mass transit, while examining a group of approaches to increase automation, we have found some potentially useful applications although we have shied away from the more extreme developments. For example, we have found that automated guideway transit (AGT) may have useful application in the form of fairly simple loops and slightly more complex variants of these loops. Downtown people movers, for example, fit this category. The more exotic extensions of this technology with these small vehicles operating on complex networks (personal rapid transit) have been abandoned as unpromising. The costs and the technological complexity of such systems simply proved to be overwhelming barriers to practical application.

Originally, because of the supersonic transport concept, but later for other reasons, we have had a lengthy investigation of the effect of aircraft operations on the upper atmosphere. It is no longer just SST's that can operate at these high altitudes. For example, the Boeing 747 SP can function at an altitude where it can potentially effect the ozone level and the climate. We have been conducting a $20 million effort known as the High Altitude Pollution Program. Using characteristic analysis in the laboratory and mathematical models for the projection of laboratory results, this study has closely examined the effect of aircraft operations on the upper atmosphere. We have concluded that the types of aircraft that we now know about, operating in numbers that can now be foreseen, will not inflict significant damage on either the

ozone layer or the climate. The High Altitude Pollution Program is expected to be completed by 1983. Efforts are now being directed largely at the examination of emerging aircraft technologies to see if there are any foreseeable developments which might upset the conclusions reached so far.

UNITED KINGDOM ROYAUME-UNI

Mr. J.P.G. Rowcliffe

When it was decided that the theme for this year's round table discussion should be Technology Assessment, I was somewhat at a loss to know how the United Kingdom could contribute. Although there has been discussion of Technology Assessment in academic circles, the concept is not a widely-recognised one with us; and we do not have, within government, the sort of machinery for carrying out assessments which has been described by our U.S. colleagues.

However, as I read the U.S. paper - which I found most interesting and useful - I realised that we do undertake a number of activities which fall within the definition of technology assessment quoted in the paper. Except in one field - which I will refer to in more detail later - we have no general methodology or machinery; but assessment of technologies does take place in various ways.

In the absence of a general methodology, I cannot comment on all the issues raised in section VI of the U.S. paper. What I would like to do instead is first to give a brief account of U.K. procedures which appear to be relevant; second to comment on those issues in section VI where U.K. experience allows us to do so; and thirdly to offer some more general reflections on the issue of Technology Assessment.

U.K. EXPERIENCE

The definition in the U.S. paper refers to "the impacts of either a technology or a project". This is, for us, an important distinction; and I would comment on the two types of assessment separately.

So far as "technologies" are concerned we have only limited experience of assessment within the U.K. Government. There have, however, been examples of ad hoc studies which could fall within the category. (I should make it clear that I am excluding from consideration assessments of existing technologies which have resulted from specific failures or accidents - I think that it is clear that the technique we are discussing is to be seen rather as a tool of an anticipatory approach to possible environmental problems.)

Of major interest here is the work of our Royal Commission on Environmental Pollution. Their work includes both a general review of environmental issues and the carrying out of specific studies. In particular, they have published a major report on nuclear power and the environment, which has provided the basis for government policy. More recently, they have carried out a study of Agriculture and Pollution which has looked at the environmental implications of developments in agricultural technology, including some of the issues such as pesticides which were mentioned by the U.S. in their contribution.

We also have a separate Commission on Energy and the Environment - set up as a direct result of the Royal Commission's study of nuclear energy. This new Commission is now looking at the implications of the production and use of coal - clearly a key issue for us in the present energy situation.

A field of increasing interest in the U.K. is potentially hazardous installations. Our Health and Safety Commission - which is primarily concerned with occupational safety but which does look more widely at industrial safety - has an Advisory Committee on Major Hazards. A major study has been carried out into the potential hazards of operations at Canvey Island in the Thames estuary. The island is the site of a large industrial complex near to a densely populated area. Among the industrial plants located there are a methane terminal, storage tanks for oil and a wide variety of other substances, oil refineries, an operation filling cylinders with liquefied petroleum gas and a plant producing ammonia nitrate. It is also near to busy shipping lanes. This study examined the likelihood of accident in the area and broadly concluded that the risks were acceptable provided that improvements to existing installations, and modifications to plans of proposed new installations, were carried out.

Similar ad hoc studies have been done in other fields. For example, a committee has recently reported on the development of Biotechnology, and we have a standing Advisory Group on the use of Genetic manipulation.

I turn now to the assessment of <u>projects</u>. Here we do have a well-developed system and methodology in our land use planning system. Any project that involves new construction, or a material change in the use of land, requires permission; and this provides an opportunity for the environmental implications to be assessed.

Within our general procedures for the control of development, which cover all projects, we have developed special arrangements for looking at particularly sensitive issues.

One example of such a study was a comprehensive report prepared some ten years ago on the choice of a site for a third London airport. This report considered a large number of possible sites, chose a short list of four and compared them on the basis of planning, environmental, aviation, surface transportation, defence and cost considerations.

More recently, we have had a particularly wide-ranging inquiry into the proposal to build a thermal oxide reprocessing plant at Windscale. This inquiry considered three significant questions:

- <u>first</u>: should domestic oxide fuel be reprocessed in the U.K.
- <u>second</u> (if yes): should it be reprocessed at Windscale, and
- <u>third</u> (if yes): should the plant be large enough to reprocess fuel from other countries.

Under these heads, a wide range of issues was examined, including

alternative ways of dealing with spent nuclear fuel, the risks of reprocessing, the risks of accident and terrorist activity, alternative sites and future controls over the plant in the event of permission being granted.

Another example is the proposed development of a major coalfield in a rural area of central England. A wide-ranging public enquiry has just been completed, and the decision will take account of the wide range of issues raised there.

SPECIAL ISSUES

Against this background, I should like to comment briefly on some of the issues in Section VI of the U.S. paper.

First, there is clearly a need to look at the possible impacts of technology. The responsibility for doing this must rest both on government and on industry. We would see it perhaps as resting increasingly on industry and, if possible, moving towards something which is nearer self-regulation than a system in which government is too much involved in the decisions of industry.

Second, one must accept in principle that there might be a need to veto a technology if the potential risks are seen to be excessive. I would suggest, however, that one needs to be very cautious about the idea of a veto, which could kill a technology which could be very fruitful - and less risky than a theoretical analysis might have suggested. Encouragement of potentially favourable technologies would seem to be a better course of action.

Third, I agree with the comments in the U.S. paper about the difficulties of weighting quantitative and qualitative factors, and about the need not to expect too much of any system of technology assessment. In the end, decisions have to be made by governments; and the best assessments can be only an aid to the taking of decisions and not a way of arriving at automatic answers.

GENERAL REMARKS

Finally, some more general observations. I do not dispute - indeed who could dispute - that the technologies and the discoveries of the past 200 years or so have not provided man with unalloyed benefit. There have been unintended and adverse side effects. We have been suffering these side-effects just as we have enjoyed the benefits of the new technologies. In order to know what action to take there is therefore a need to try to ascertain what the benefits and disbenefits of new technologies will be.

I believe however that we should be cautious in our application of this approach. We should also be cautious in using the results of TAs to guide decisions. The path of development of new technologies cannot always be imagined. They may, for instance, be usurped by other technologies within only a few years. What is more, the process of TA must suppose that the technology being considered will develop in a society organised on the lines obtaining at the time of assessment. For example, whilst a European assessor

in 1900 might have anticipated developments in the internal combustion engine leading to greater speed and range of vehicles he might not have anticipated the social order of 1980 and the spread of individual car ownership.

It is important also to avoid the introduction of over-complicated methodologies. These can easily prove to be burdensome on industry without achieving the ends of those who conceived them. They therefore have to be modified over time. Better in our view to allow a system to evolve in response to, or perhaps slightly ahead of, public demand; to strike a balance between present political need to respond to people's concerns and the need to assess as far as possible future implications.

There is a balance to be struck here. Clearly, we must try to avoid repeating the mistakes of the past. On the other hand, the success of the Western economies depends to a large degree on innovation and the development of new technologies, and we must not needlessly impede that progress.

The conclusion that I draw is that it is right to give attention to the need to assess the impact of technology. But any all-embracing methodology is likely to bring problems, and a pragmatic approach - applying assessment when there is seen to be a need for it - is, in our view, the better answer. It seems likely, therefore, that in the U.K. our approach will continue to be an ad hoc one - through the carrying out of specific studies of particular technologies where necessary and through the development of our land-use planning system.

I have, however, found it very useful to hear the views of other countries - and I look forward to the further contributions which are to come. And I should like to record my thanks to our U.S. colleagues for introducing this subject and for their very stimulating paper.

GERMANY ALLEMAGNE

Dr. Günther Hartkopf, State Secretary
Ministry of the Interior

The great majority of the citizens within the European Community hold the view that the risks connected with technical progress are increasing continuously. This is the result of an opinion poll carried out in the Community last year. Half of the persons questioned expressed the fear that technical know-how and technical inventiveness, at least in the Western industrialized world, too often lead to large-scale technical application; it might be impossible later on to ward off the negative consequences of such a development by technical means alone.

Obviously, our citizens no longer recognize technical progress as the motor of human progress. Particularly, younger people doubt whether technical progress automatically brings about more happiness for the well-being of the individual and the society.

We are at the beginning of a new development with which the politically responsible now are increasingly faced within the Western industrialized world. The citizens' doubts reveal a deeply rooted uneasiness:

- Is it, against the background of our social and ecological situation, still justified to strive for the technically feasible at any price, if only it can be reasonably put into practice from an economic point of view?

- Aren't those people right who want to set new priorities or at least call for alternatives before decisions are made to introduce a new technological development?

Those who put forward questions along this line will easily find examples showing that their doubts are justified - and this does not only apply to the field of nuclear energy and its safe use!

Some examples taken from ecology and environmental protection may prove that the concerns of our citizens are justified:

1. It is said that the scarcity of resources, the safeguarding of supply, interests in the field of foreign and security policy as well as economic reasons, compel us to extend the extraction of crude oil to the continental shelf of the oceans. Nobody wanted to admit that such extraction can entail serious risks for man, for the recreation areas on the coast and for the aquatic environment. The leakage at two drilling sites off the Mexican coast and the oil rig accident in the Ekofisk field have opened our eyes.

2. The system of transport of crude oil in large-capacity tankers was promoted and put into practice for purely economic reasons. Only now - after we have been confronted with the disastrous effects of the increasingly frequent tanker accidents - international strategies are being developed which are to reduce the risk of accidents.

3. The long-term problems related to chemical substances: for example, life of the consumer has become more comfortable since spray cans filled with fluorocarbons as propellants are abundantly available. We once praised these amenities - which are in no way essential for life - as being a "progress". Now we have to question their use worldwide as the dangers implied for man and the natural balance, brought about by the destruction of the ozone layer of the atmosphere, is becoming increasingly obvious.

Further examples which reach far out into the socio-cultural field are easily to be found: I only have to think of the question whether our "automobile-based civilization" should be continued without limitations or how to manage the problem of the new communication technologies.

The answer to the uneasiness of the citizen with regard to technical progress, the answer to the technical development which has become a problem is the demand for an institutionalized procedure of technology assessment. This, of course, should be a technology assessment which goes beyond what we understand by it so far. A characteristic of most procedures of technology assessment applied today is the sectoral approach. After all, it was possible to achieve that the new technologies, prior to their application, are examined and evaluated as to their

- technical maturity and reliability;
- safety for manufacturers, consumers and other people;
- economic applicability;
- and finally, even environmental compatibility, or at least approaches thereto.

Success achieved in this connection is quite considerable. Subsequent to my basic remarks, Mr. Leitterstorf of my delegation will report on the present state of affairs in the Federal Republic of Germany.

However, we may not stop here! The examples given before were to show how urgently the industrialized countries with their highly developed technical civilization need a comprehensive "early warning system which would help man to protect himself against his own inventions"; I fully support this demand expressed by Jerome Wiesner, President of the Massachusetts Institute of Technology. I want to make clear what I mean: In the future technology assessment must be based on a comprehensive approach instead of being focused on specific sectors. The report of the Club of Rome on "The Limits to Growth" has already shown that a sectoral approach to problems will not be adequate any more. Confining the assessment to practicability under the sole aspects

of technology and private business including the relevant safety and security questions will not do. In future additional analyses are required that make it possible in time

- to show the impact of the relevant project on human health and on man's environment, on his social and cultural needs;

- to shed light on the demands caused by the project on ever more scarce resources;

- to reveal the impact of the project on national and international economic, financial and social policy

and, if required

- to submit proposals for national legislation.

This catalogue is not complete - it only lists the most important points. The results of these analyses should make the project and all implications transparent to the citizen and provide those responsible in the spheres of politics, science and economy with alternatives for decision-making.

In the Federal Republic of Germany we have made an attempt to introduce technology impact assessment according to this new comprehensive approach in one field. This, of course, is in the field of peaceful use of nuclear energy. In the German Study on the Risks of Nuclear Power Stations, the so-called "Birkhofer Study", an attempt has been made for the first time to analyse the relevant safety risks involved in the operation of nuclear power plants in Germany and to evaluate them with a view to the future and thus to obtain reliable decision-making criteria on which to base our own safety practice. The so-called "Gorleben Hearing" has brought together national and international expertise to make a comprehensive assessment of the technological, ecological and social impacts of the processing of spent fuel and of the ultimate storage of nuclear waste. In 1979, the Bundestag set up a special commission consisting of seven members of parliament and seven independent experts to prepare a study on "Future nuclear energy policy". It is the task of this commission to show - with a view to the peaceful use of nuclear energy - the future decision-making possibilities and needs under ecological, economic, social and safety and security aspects and to prepare relevant recommendations, taking both national and international developments into account. This commission has, inter alia, been expressly charged with the task of

- showing possible effects of energy technology on social processes and making suggestions for the prevention of any undesirable developments

and with the task of

- describing and evaluating possibilities and consequences of any future stop of nuclear energy utilization.

We expect the final report will be available in the summer of this year.

I think this attempt to analyse and prepare in a comprehensive technology assessment the future lines of development with regard to the peaceful use of nuclear energy and to show possible alternatives, already permits to state the following:

1. At last the request is taken seriously to open up new fields to technology assessment and to expand and differentiate its methodological instruments.

2. To me another, second, conclusion appears to be equally important. This new approach to technology assessment will have to bring together a number of problem areas covered by different scientific and technological disciplines. It is foreseeable that the relevant interest groups from science, economy and politics will exercise their influence. However, we must not allow the technology assessment to be left one-sidedly to these interests if we want it to remain trustworthy for the citizen. In this context another conclusion suggests itself: In addition to new contents, new institutional forms must also be developed for the technology assessment.

The belief is wide-spread that it would be sufficient to improve the structure of existing mechanisms. This is certainly a point of some importance. So, for example, the appreciation of the trend-setting importance of a comprehensive technology assessment still leaves much to be desired. Everything should be done to make the decision-makers in government, economy and research institutions fully aware of what is at stake. Another field lending itself to the enlargement and intensification of already available instruments would be the environmental impact assessment of all relevant decisions. However, mere improvements of already existing structures will not be sufficient. What seems necessary to me is a completely new approach which takes account of the fact that the citizen will only accept an assessment of the impact of technologies if two conditions are met:

- a high degree of expertise

  and

- independence

on the part of those who are called upon to assess a technological project with a view to its consequences. The reservations and fears of the citizens in the face of new and complex large-scale technologies - and these are of major significance in this context - can only be alleviated if we find an institutional form of technology assessment which guarantees authority through expertise as well as independence of influences exercised by interest groups. Starting from this premise, I am sceptical about all ideas aiming at the setting up of an institution for technology assessment at state level, whether with the governments or with the parliaments or with the lawcourts of our countries.

We should reflect on ways and means pointing beyond the American model of the "Office of Technology Assessment " (OTA) established with the U.S. Congress, or the Swedish model of a "Society for Members of Parliament and Scientists" (RIFO) instituted with the parliament. The German Federal Government has not yet made any decision on the problem of institutionalizing the assessment of the impact of technology. The statements I am now going to make should therefore be regarded as a first and very personal contribution to the discussion - to stimulate thinking, as I may say - in order to point out a trend for our talks at this Round Table.

I have recently suggested the establishment of a technology assessment committee completely independent of State influence, which would have to meet the following institutional requirements:

- It must be open to appeals from all governmental decision-making bodies, but also from non-governmental organizations which, like business enterprises or civic associations, can furnish proof of a justified interest.

- The committee must be independent of influence from interested parties. Its findings, neutral in value, must be beyond any doubt if they are to contribute to the development of social consensus by their weight and their persuasive power. I know how difficult it will be to find really independent and highly qualified experts. But why should we not also call upon personalities from other countries?

- On the other hand, the proposed institution must not give any justified occasion to be reproached with "spoon-feeding" of scientific research.

These are preliminary thoughts which will have to be discussed in depth in my own country. Worth considering in this connection, as I see it, are the concepts developed in scientific discussions in the United States on the model of a "Science Court", concepts which right now have triggered off an intensive discussion within the learned community of the Federal Republic of Germany

Allow me to make a concluding remark. Without our noticing it at all times, there has taken place a "silent revolution". We are living with "technical achievements" which we did not want to be the way they are, which dominate our life and which we can no longer annul. Those responsible in the political domain, in the economic field and in our society will have to realize after all that we need an interdisciplinary and inter-policy technology assessment with a firm institutional framework. Governments, parliaments and the mass media must accord to questions of technology development the place that is due to them. Technology assessment, as I understand it, can be a decisive factor in alleviating the citizen's uneasiness, referred to in the beginning, about technical development: Greater intelligibility of decision-making processes, pointing out alternatives for decision, and

elucidation of the economic, social and ecological consequences ensuing from the introduction of new or the modification of existing technical developments.

I believe our countries need a really independent institution which

- supplements our scientific-technical consultation system by a future-orientated component,
- by virtue of its pertinent authority convinces those who, in the governmental sphere, in the economic field and in society, are called upon to decide on the advancement and use of new technologies,

and

- encourages social consensus and in so doing diminishes distrust towards technology.

Any discussion of this complex subject would fall short if it were confined to national boundaries. Technology assessment is of concern to all states with a highly developed technical civilisation. I therefore welcome the initiative for an international exchange of views on this subject that has been taken by this very Committee, the CCMS, as a forum of countries with a highly developed technical civilisation. We should continue this discussion. As a first step, I am thinking of a symposium in the framework of the CCMS, which would convene experts from our countries for an in-depth exchange of views on the problems we have raised today. Thereafter, models of an institution for technology assessment could be worked out and discussed within the CCMS. Such a follow-up to the discussion we have begun today would be of great benefit to all of us. I should be thankful if advantage would be taken of the chance that is offered to us.

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Dr. R. Leitterstorf, Ministry for Research and Technology

I. Cooperation between State agencies, research institutions and other organizations in the assessment of technologies in the Federal Republic of Germany

In view of the fact that the objectives of governmental planning and action in the fields of research and technology became more sophisticated in the seventies than they had been in previous decades and, correspondingly, took more account of social, economic and political interactions with the technical system, it would indeed be unfounded to regard the development and utilization of technology in the Federal Republic of Germany

or in other industrialized countries of the West as having been a chaotic "laissez faire" up to that time.

In reality, the endeavour to "domesticate" technology, to use it in a manner that is helpful and beneficial to man, has a long tradition, and - although we only gradually begin to recognize some of the perspectives of technical civilization - has by no means remained without success.

In Germany, for example, administrative regulations under the Industrial Code, as well as measures of industrial safety and environmental protection, have been conceived and applied since the middle of the last century under comprehensive technical guidance provided in particular by the so-called scientific-technical associations, such as the VDI (Verein Deutscher Ingenieure). This also applies with regard to the regulations and legal provisions governing the licensing and operation of technical installations and also with regard to the development of technico-scientific and legal instruments for standardizing the use of technologies.

There is no doubt that, under the pressure of decisions and problems which has been caused in the last few decades by the growing difficulty to get a clear view of the chances and risks involved in complex new technologies, the idea of a systematic assessment of technologies has opened up new perspectives and has given new impetus.

However, some advocates of a more strongly formalized Technology Assessment - ranging from simple cost-benefit analyses to "global modelling" - tend to overestimate the rôle of perfected methodical procedures in the discussion on methods of Technology Assessment, while, on the other hand, they underestimate the difficulties involved, not at least with regard to the needs of practical policy.

It is evident that every technology of some importance, when its direct and indirect effects are taken into account, can be brought into connection with almost any problem areas of our civilisation, and even with most actual political topics at a given time. How rapidly this may bring about a change in the assessment of technologies will be shown by the following example: Labour-saving technologies were most welcome in the Federal Republic of Germany during the sixties because manpower was lacking and no one lost his job as a result of such technologies. Today the labour-saving character of technical progress is a front-page political problem because the labour market situation has fundamentally changed.

It will have to be shown by the example of the Federal Republic of Germany that Technology Assessment can only be a continuously developing pluralistic process of information gathering that serves as a basis for reaching consensus and for decision-making.

With regard to cooperation between state agencies and other institutions, it should be mentioned first that in the Federal Republic of Germany there are quite a number of state agencies which have an influence on the use of technology and its further development. This may happen through procurement and procurement directives, by ordinances and laws in various fields or their implementation and supervision by promotion and financing of research programmes, or even by administrative court decision in certain cases at law.

In this connection, the following governmental institutions and authorities exercise important "regulatory" or innovative functions:

- the Bundestag (Federal Parliament) and the Bundesrat (Laender Chamber) by their legislation or in deliberating programmes concerning the promotion of research and technology and their financing;

- the various Federal Ministries, to the extent that they prepare or issue laws and decrees having a standardizing effect on the use of technology (e.g. in the fields of environmental protection, food law, industrial safety, building regulations) or promote the development and use of specific technologies;

- individual subordinate federal authorities charged with the testing and licensing of substances or new technologies, e.g. the Federal Health Office in its competence for the licensing of medicaments;

- the governments and authorities of the federal states in the framework of such functions as the implementation and supervision of measures in the field of environmental protection, the licensing of installations and plants for which a license is required by law, or in the framework of trade supervision.

As regards decisions on questions of technology, scientific guidance and research are becoming more and more indispensable. Important functions in this respect are discharged in particular by:

- the Federal Environmental Agency;
- the federal research institutes affiliated to individual Federal Ministries;
- the large-scale research institutions, which are mainly financed by the Federal Government;
- the Council of high-level Experts on Environmental Questions;
- the Reactor Safety Commission and the Radiation Protection Commission;

- the Ecology Project Group;
- the German Society for the Advancement of Scientific Research, jointly financed by the Federal Government and by the Laender, which in addition to its responsibility for the promotion of research at university level is discharging important counselling functions.

In order to deal with focal problems of research, but also with problems concerning the use of technology, it has established more than 20 scientific commissions, e.g. the commissions

. for the examination of substances hazardous to health,
. for the examination of artificial substances in foodstuffs,
. for research on air pollutants,
. for safety problems relating to new combinations of genes.

These commissions and the results of their work are available to the legislator and to authorities preparing relevant laws and ordinances.

In addition, a number of university institutes and many private research institutes are working for the various Ministries by giving expert opinion or in the framework of research contracts.

Another aspect which should not be underestimated is technical standardization and safety control of plants and machinery, as well as the development of technical directives, by the so-called "technico-scientific associations".

Today the technical directives of the "Verein Deutscher Ingenieure" (VDI), established already in 1866, and the work of specialized commissions such as the VDI Commission on "Air quality management" constitute important basic instruments for legislation and administration. Apart from the VDI, there should be mentioned in particular:

- the Association of German Electrical Engineers,
- the Technical Inspection Association, and
- the German Institute of Standardization.

II. Approaches to an assessment of future technology development and use

In order to demonstrate in some more detail the mechanisms of the scientific and political assessment of technological development in the Federal Republic of Germany, two fields of activities should be considered, namely

- governmental research and technology policy, and
- environmental policy.

They are significant areas for the development and design of technology.

1. The development of governmental programmes for the promotion of research and technology

Until the late sixties, governmental promotion of research in the Federal Republic of Germany was mainly focussed on programmes which had been conceived under aspects of scientific interest and of the scientific and technical "backlog demand" in comparison with other industrialized countries.

In the course of the seventies - like in other Western countries - the aspect emerged that science and technology should contribute more than during the past to the solution of social and economical problems.

Therefore, and along with other programmes involving social objectives, in particular the humanization of working life as well as research and technology in the service of health, in the seventies also "bottleneck-orientated" programmes were established, aiming at the supply of energy and raw materials, for example, the programmes 'raw material supply' and 'environmental research'.

Already in their drafting stage these programmes required intensive Technology Assessment from a scientific, economic, social and political point of view.

Therefore, scientific guidance and political coordination were developed and extended considerably in the framework of research policy. Today, the assessment of governmental promotional activities mainly comprises the following elements:

- formalization of the programme structure according to aims, motives and measure of promotion,
- as a rule, political harmonization of draft programmes:
  - at the level of the Federal Ministries,
  - with the organizations concerned in the sector of trade and industry and with trade unions and professional organizations,
  - with the responsible committee of the Deutsche Bundestag.
- where appropriate, joint preparation and shared implementation of promotion programmes by several ministries, in order to be able to proceed in a problem-orientated manner without being hampered by ministerial competences,
- consideration of the programmes and of the individual promotion projects within consulting bodies composed of external advisers and the appropriation committees of the ministries,

- evaluation of programme objectives and analysis of the impact of new technologies and of technology requirements by awarding contracts for external studies and expert opinions,

- application of the concept of project implementation in progressive steps, so that decisions on promotional action can also be reviewed in the light of new knowledge,

- information of the public on a large scale about governmental promotion of research and technology, in order to make it possible to introduce criticism from the public into the planning process.

2. Technology assessment in the framework of the environmental policy of the Federal Government

In the environmental policy of the Federal Republic of Germany, technology assessment and technology impact assessment are of focal importance. The consequent implementation of the principle of anticipatory action ranks, together with the polluter-pays principle and the principle of co-operation, among the three most important elements of German environmental policy. It is unthinkable and not possible without technology assessment and technology impact assessment.

Questions concerning the technology impact assessment are, as already mentioned, dealt with especially by a specific independent expert body, the Council of High Level Experts for Environmental Questions, and by the non-ministerial Project Group on Ecology.

A particularly significant instrument for the implementation of the principle of anticipatory action is the environmental impact assessment. It covers the environmental aspects as well as certain social aspects as part of an overall technology impact assessment. The "Principles of environmental compatibility of Federal measures" as adopted by the Federal Government in August 1975 are aimed at an early assessment of:

- environmental relevance; and
- environmental compatibility.

This goes for all public measures taken by Federal authorities, e.g. programmes (thus including research programmes), plans draft legal regulations, administrative actions and agreements, etc.

As far as these principles do not yet meet all expectations, this is partly due to the fact that specific procedures and methods are not yet fully available. Moreover, some awareness is still lacking with regard to the necessity of the environmental impact assessment, i.e. acceptance of the principles which, representing a compromise, have been formulated without rigorousness anyway. This attitude may be found in isolated cases in the spheres of politics, administration and

economy. This follows from the fact that the environmental impact assessment and thus technology impact assessment and evaluation will inevitably entrain disclosure and possible public discussion of the consequences and conflicting aims of intended measures of public authorities and thus more transparency in planning and will therefore also make the public more aware of the problems concerned.

3. Important topics in the current discussion of technology policy in the Federal Republic of Germany

A number of problems emerging from the technical development during the last few years require an 'inter-programme' analysis and discussion.

At present the following problem areas are of particular interest in this respect:

- relation between technical progress, international competitive capacity, and employment;
- job-related effects of micro-electronics under qualitative and quantitative aspects;
- safety problems, ecological and social impact of modern technologies;
- use of new and alternative technologies to safeguard the supply of energy on a long-term basis and with minimum damage to the environment;
- technological requirements regarding the availability of resources and the preservation of ecological balance to the largest possible extent;
- elicitation and limitation of possible risks involved in gene research and gene technology.

III. Concluding remark:

This short statement can only give a rough outline of the system of pooling information for technology-relevant decisions. It was not possible, for example, to give a more detailed description of the instruments available to parliament for the development of their decisions (hearings, inquiry commissions, questions to the government) or of the effects emanating from economic policy, for example through measures in the field of tax-policy or by subsidies.

Moreover, I did not deal with discussions inside political parties nor with the development of 'citizen-initiative groups' which during the last few years have been a source of essential impulses in the direction of a changed way of looking at our technological system. I hope, however, that from this statement a first impression may be gained of the plurality of technology assessment in the Federal Republic of Germany, which - perhaps because of its diversity - has so far always made it possible to reach some acceptable compromise.

GREECE

This contribution, although not read at the meeting, was distributed by the Greek Delegation

GRECE

Cette contribution, bien qu'elle n'ait pas été prononcée au cours de la réunion, a été distribuée par la délégation de la Grèce

Technology assessment (TA) is one of many techniques and methods which were introduced in the early 1970s to respond to the excesses of the technological evolution which took place in the 1960s. The main characteristic of the new technologies was the very large size of production units. This was aggravated by the public appetite for consumer goods.

Thus, it was not only the effect of a few 500 tons per day ethylene plants but of a large number of them which were needed to meet the projected demand of a plastics consuming society. It was not only the 1000 mega-watt nuclear power plant but also the siting of them as clusters of four such units, and the planning of the virtually fictitious 40 thousand mega-watt nuclear power "park". Again, in areas where specific government agencies carried out some kind of TA e.g. in the introduction of new pharmaceutical products, the invention of many new products in a relatively short period led to mistakes of the thalidomide type.

The environment protection movement of the 1970s was largely responsible for the introduction in many NATO-member countries of TA of the type of the U.S.A. Environmental Impact Statement (EIS), while other countries where land-use planning was a tradition, as in the United Kingdom, found it necessary to update existing legislation to meet the public demand for the protection of the environment and to face the adverse impacts of new technologies (Town and Country Planning Act 1971).

The high rate of introduction of new technologies in the 1960s has its sources in a pool of radical innovations which appeared during and immediately after the second world war. It was fueled by the booming economies of NATO member countries in the 1950s and 1960s.

The need for TA was a result of these two trends.

The political, economic, social and technological conditions in NATO member countries are different today from those of the 1960s. And they will diverge even more in the years to come. The first question is therefore if TA will be needed, and if the answer is on the affirmative, then the second question is if TA should follow the lines defined earlier.

Statistical figures collected by the OECD show a decline in the investment in R and D in OECD member countries and particularly in basic research for the period 1970-1978. The number of patent applications has also declined. And the introduction of new, radical technologies has slowed down even more, with one exception in the field of electronics.

Recent developments and projected trends for raw materials, energy resources, employment, inflation and investment have led many governments to consider important changes in their national industrial structure. A wider geographic dispersion of production units for some basic and intermediate industrial products is now accepted as inevitable. The shift in NATO member countries to the production of more high value added products is also an accepted trend. The need for radical new technologies to deal with the shift to new energy and raw material resources is again an urgent need. It may also happen that the elasticity for imports of raw materials, foodstuffs and may be other products is reduced to the extent that domestic production based on other than the traditional raw materials becomes inevitable. Lastly, environmental and social considerations (e.g. unemployment) may lead to gradual redistribution of the populations and to changes in our way of life. The cherished productivity of the 1960s may yield its priority to full employment, use of national resources, increased food production, use of less energy containing products, better and cheaper telecommunication systems, improved social services, etc. To meet these ends and provided that world peace is maintained, the Western world will have to undertake a major R and D effort.

A clear indication to that end appeared in the last two years. The Federal Republic of Germany and the Netherlands increased their national R and D expenditure. They were followed by the U.S.A., France and Japan. More countries are expected to follow. Furthermore, the importance of basic research is recently underlined in many governmental science policy documents. These indications show that the emphasis of the R and D effort will be on the development of radical new technologies rather than on incremental innovation as was in the 1970s. Work to such ends is well underway in some areas: biochemistry, enzymology, nitrogen fixation, bioengineering, microelectronics, solar energy, etc. Although the aims of such research in terms of new processes and products are known, their possible adverse consequences are not always contemplated. To meet that end, it might prove useful to introduce TA at the R and D stage in the hope that the technologies which will be introduced in the late 1980s and 1990s will be appropriate to the needs of our societies.

These needs may be much different from those of today. Consequently market forces will not be sufficient by themselves to direct the R and D efforts to the development of these appropriate technologies. The large investments in R and D, the long lead times, the competition among firms and among countries, and the need of replacing established raw materials may encourage the adoption of new radical technologies despite possible adverse environmental and social effects.

To bring together the long-term social ends and the available technical means, and to allow for preventive rather than corrective measures, it may be useful to incorporate TA in the R and D phase. Governments are best placed to initiate the introduction of TA at the R and D stage because of the following reasons:

(a) They are best placed to ensure the coupling of national economic, social and technological policies on a long-term basis.

(b) They have a major responsibility for the protection of the environment, for land-use planning for public health, for safety of work and for many other social services.

(c) They issue and enforce legislation governing the siting of industrial facilities, the zoning of land, and the use and application of technology.

(d) They are an important source of R and D funds for universities, research centres and for the private sector.

(e) They run through the appropriate departments research centres and laboratories in agriculture, medicine, defence, new energy resources, mining, social services, etc.

(f) They have an influence on the technological policies of public enterprises such as utilities, telecommunications, transport, etc.

Industry, on the other hand, carries out TA to ensure that its products and processes are not harmful to the public and that governmental rules have been followed. There are many instances where industry has gone out of its way to describe government legislation as repressive and forbidding. A lot of publicity has been made by both European and American pharmaceutical firms on the reduction in the number of new drugs which was attributed to the FDA legislation in the U.S.A. and the Dunlop Report in the U.K. The reduced numbers of new drugs are associated only to secondary drugs and not to the introduction of new chemical entities. Furthermore, the phenomenon has many other explanations: many illnesses have found their cure, the search for new antibiotics is more difficult, etc. Therefore, although the participation of the private sector in TA at the R and D stage is indispensable the responsibility seems to be better placed with government.

To carry out TA at the R and D stage managers and researchers have to be alerted to that need through information and education. Interdisciplinary teams including researchers, producers and probable users of the technology as they are described in the U.S. contribution seem to be most appropriate to carry them out. The reluctance of scientists to adopt such practices, which is to be expected, may fade away if it proves useful in clarifying their aims and becomes common practice.

Such a "stategic" TA does not preempty the need for TA when the technology is introduced in its final form, or when it is installed in a specific geographical area. In the latter case the participation of regional and local government, of industry and other interested groups as well as of citizens is necessary. Indeed this is the case in Greece now when the installation of the first nuclear electricity generating plant

is being considered.

The aim of this note is, however, to underline the need for preventive TA at the stage of R and D. And it does seem that now when the needs for radical new technologies are shared by most NATO member countries, such TA may be carried out as well in cooperation on an international basis among R and D laboratories which are working in the same field.

NETHERLANDS PAYS-BAS

Ambassador Hartogh

I think we should be very grateful to the United States Delegation for their initiative in launching this discussion. The various statements we have heard have shown that there is a great interest in this problem, but that there are some differences in approach. I was struck by Dr. Hartkopf's suggestion that we might give some further attention to this question, perhaps in the form of a symposium. It is a good idea which we might discuss later on, and I think I would support it.

The rôle of the Dutch government in controlling technological developments has increased significantly since the year 1972. Before that year, the environmental concern of the Dutch was not developed beyond the normal level known in other West European countries. But the first report of the Club of Rome - "Limits to Growth" - had a considerable impact. Some 100,000 copies were sold in the year 1972. Many people for the first time began to realize how important the environment was, and environmental concern became a political issue in many ways. This political debate has resulted in a shift in responsibility from industry to the government for anticipating the adverse effects of technology. Illustrative of the changed attitude of the Dutch government is a white paper published in 1976 and titled "Selective Economic Growth". In this white paper one can clearly recognize - in much the same way as has been described in the OECD report "Science, Growth and Technology" of 1971 - the dualistic role of the Dutch government with respect to technology. This white paper mentions two types of economic policy. Next to the traditional type of stimulating policy, there is also a regulatory one.

An important element of the latter - the so-called "aspect oriented policy" - is that criteria for control are defined which are aimed at energy conservation, environmental control, regional planning and the relation to the Third World.

After the change of government in 1977, many elements of these policies are still present and have been reformulated in a white paper on innovation, published in 1979.

In general we can conclude that the cooperation between the Dutch government and industry has shown an evolution from a rather passive stimulation of industrial development to a more active policy of control in the sense of adaptation and steering on the basis of social and environmental priorities.

I will now present a summary and a classification of the various analytical tools, case studies and governmental bodies which have been involved so far in governmental policies for anticipating and forestalling the adverse side effects of technology.

To avoid confusion on terminology, the same definition for TA - as given in the Round Table discussion paper - will be used for the classification of the vsrious case-studies. As another safeguard against confusion, we will proceed with a classification made in an order that is based on the degree to which actual TA is involved.

First of all, the definition of TA used for this round table discussion mentions "a class of policy-oriented research", in which the degree of actual TA is rather low.

A host of policy analysis studies belonging to this category have been performed in the Dutch government by:

- the commission for development of policy analysis (COBA)
- the council for science policy (RAWB)

Second, a study may be aimed at the anticipation, identification and evaluation of secondary impacts (side effects) that go beyond questions of technical feasibility, costs and safety. Various studies in this category are performed by:

- the social and cultural planning office
- the scientific council for governmental policy (WRR)
- the central economic planning office (CPB)
- the central council for regional and urban planning.

Third, studies may be considered in which the consequences for society of a specific technology or a technological project are evaluated.

In this category we can place the studies performed on nuclear projects, like the Dutch participation in the "Kalkar" fast breeder project and the enlargement of the enrichment plant at Almelo; also the case studies done on offshore projects in the North Sea, mostly gas-drillings, can be placed here.

We do not have in the Netherlands one organisation which combines the just-mentioned three elements in its working programme. However, on an ad hoc basis three case-studies have been made, which do combine these three elements. A more detailed description of these three studies will be given later on.

Before this will be done I would like to add an extra dimension to the definition of TA, just as has been done in the discussion in the U.S.A. Relating to this discussion on TA and especially to the way the Office of Technology Assessment functions in the U.S. political system, one can state that a full-scale TA-study should include the following elements as well. One of these elements - the fourth in my classification - has not been stated explicitly in the definition we used so far. One can argue that a TA study should clarify a range of policy options and the potential impacts of adapting each of these options. In this category, nine "environmental impact statement" test studies have been performed and in my country probably this year a new law will demand such studies for "any major government action significantly affecting the quality of the human environment".

As a fifth element one can distinguish the participation of affected groups or public interest groups. Several reports and white papers, for which the so-called "procedure for regional key decisions" has been used, deal with this element.

As a sixth element of a TA study one can point to the parliamentary role of control over the administration. No studies have been performed yet which can be classified in this category.

Using this full-scale definition of TA, no case studies can be mentioned, which meet the requirements of all six mentioned elements. Already has been stated that three case studies have been performed in the Netherlands which do comply with a definition of TA in a more restricted sense.

First, I will mention the Oosterscheldedam project. In cooperation with RAND corporation, a report on this project published by the royal commission Klaassesz in 1974. Under pressure by several parties in parliament more side effects have been evaluated and an extra alternative was added later. For those who know more about this project, I would like to specify that this extra alternative, which is now implemented, is a half-open dam with closable caissons. The methodological set-up of this study did not fit into the concept of TA, but the final report shows that all elements of TA are included.

What might be another interesting project for the TA concept is the case study on an artificial North Sea industry island. Considering the fact that one alternative has been deliberately excluded and that no efforts for participation by affected groups have been made, the result of this study can hardly be called a full-scale TA.

The last case study I wish to report deals with the introduction of micro-electronics in modern society. This report has been published by the royal commission "Rathenau" in 1979. A restricted range of alternatives have been evaluated - maximum stimulation, no stimulation and average stimulation of the introduction of micro-electronics. Affected groups did not participate in the process of defining and shaping the course of the study, nor did they review the findings before they were released. Though this case study complies with a definition of TA in a restricted sense, it falls short of the qualifications of a case study matching the standards we wish to apply to the concept of TA. I would like to add, however, that both government and parliament wish to introduce to a larger extent the concept of TA in future planning.

I should like to add two final points. I have laid stress on elements of technology assessment, in particular in the environmental policy field. Although no clear overall definition of TA has yet been developed, in my country, in a number of other policy fields, elements of TA have been introduced as well.

Lastly, allow me to put a question to the United States Delegation. Technology Assessment as defined in the United States paper has led to some confusion, at least within my Delegation. It is not very clear, for instance, whether TA also includes environmental impact assessments or whether these should be considered as two separate policy instruments. If

the United States could give an answer to this question during our forthcoming discussion, I would be very grateful.

CANADA CANADA

Mr. P.J. Beaulieu

Undoubtedly much of the impetus for assessment of the impact of technology has come from an apparent public disenchantment with science and technology that followed a period of equally misplaced faith in the technological fix - that man's ingenuity could solve all the problems that were likely to confront us. Seen against a background of wartime application, environmental degradation caused by reckless industrialization, and finally mounting social and economic problems apparently caused by a concept of limitless conventional economic growth, it is not surprising that questions began to be asked about the value of technological expansion.

As pointed out by speakers before me, there are many ways of looking at technology assessment, ranging from the narrow assessment of the impact on the biophysical environment of a large industrial project to the social impact of an invention or innovation. Sometimes the assessment is vital to making short-term regulatory decisions, sometimes medium-range investment decisions and at other times long-range planning decisions in the social sphere.

Partly because of this, and partly because of our federal structure of separate and shared areas of jurisdiction and legislative power, there has been no attempt to institutionalize technological assessment in Canada as is the case for many countries represented around this table. Both the federal and provincial governments, however, have been responsible for a number of initiatives that can legitimately be called technology assessment, and have stimulated, or at times compelled, industry to participate. And the interest of a generally well-informed public has usually not needed any stimulus to demand involvement.

Technologies have always been assessed. Concepts such as efficiency, return on investment and the production function are all concerned with the evaluation of technology, and private enterprise has done this job very effectively. But the widespread application of some technologies leads to impacts whose social returns are more important than private returns, so that the "natural" assessment process fails. Typical examples of this are situations when optimal individual behaviour results in sub-optimal system behaviour (for example, the use of private automobiles instead of mass transit facilities).

Faith in technology assessment as a new discipline in the policy sciences is not based on a long history of successes, but on the hope that the additional perspective gained by placing greater emphasis on social returns, will lead to a more rational development of technology in our increasingly complex and interdependent modern society. Short-range ad hoc responses to the problems of growth and change are often inappropriate and pose even greater problems for the future, but we must not forget in our enthusiasm for a new approach that, as the demand for technology assessment grows, the search for ever more sound methods of assessment must go on.

The ultimately political dimension of assessment of the social impact of technology carries with it an aura of an adversary system and potential regulation. Yet one must be careful not to take a negative approach - the assessment process can also be a powerful planning tool to promote the technological strategies that we need in shaping the future that we want to see.

While we have not tried to institutionalize technology assessment per se in Canada, various mechanisms have been put in place by all levels of government that essentially impose its techniques.

Thus we find that the Government of Canada now requires that any proposal to create new regulations of any kind be supported by a 'Socio-Economic Impact Analysis'. This is intended to identify and evaluate both the results of regulating and not regulating, and, as these analyses are public documents, they are designed to draw the public into the decision-making process. The governments of Canada and several of the provinces have implemented Environmental Impact Assessment and Review Processes to evaluate the possible results of technological applications in proposed development projects. The past two decades have seen the creation of new government agencies at both levels concerned with consumer and corporate affaires, hazardous products, environment, resources, energy and science and technology, all with the intent of influencing the policy process through use of the best available technology. This, in turn, implies increasingly wide-ranging assessment of these technologies.

Among the most spectacular results have come from the adversary system innerent in the various federal and provincial laws that relate to public enquiries. Two outstanding examples are the federal government's Mackenzie Valley Pipeline Inquiry, and the Ontario Royal Commission on Electric Power Planning. Unfortunately I only have time to deal with one of these, and have chosen the former because of the innovative style developed by the Commissioner, Mr. Justice Berger, of the Supreme Court of British Columbia.

Shortly after the discovery of large oil and gas reserves in the Arctic in 1968, plans were made for a gas pipeline connecting Prudhoe Bay, Alaska with the Mackenzie Delta, NWT, and then running south to U.S. and Canadian consumers 5,000 km away. Early estimates gave a cost of $8 billion and indicated that construction could be underway by 1973. But in 1972, the Canadian government issued a set of guidelines that forced applicants to submit a detailed environmental impact statement, and assume the burden of proof that any pipeline would be both socio-economically and environmentally acceptable.

Originally, a single consortium, Arctic Gas, was formed which spent $50 million on research studies, and also funded an "independent" Environmental Protection Board, to perform a separate assessment. Growing public concern, including land claims and opposition of northern native peoples to <u>any</u> pipeline, caused the government to establish a public inquiry into the project.

On the basis of preliminary hearings, the Commissioner decided that the enquiry should not be limited to the Arctic Gas Consortium proposal, but should encompass all potential activities related to a Mackenzie Valley Transportation Corridor and their economic, environmental, human and cultural impacts. He devised four sets of hearings - formal, special, community and southern hearings.

The formal hearings considered evidence related to construction proposals, technology, guidelines and environmental impacts; disclosure of all reports in the hands of industry, government and public interest groups was made mandatory. Special hearings involved testimony from potential producers on their exploration in the Mackenzie Delta and Beaufort Sea, and were aimed at environmental risks and protection measures, as well as economic impact on northern communities. Southern hearings were held in the major cities across Southern Canada, where 85 percent of the population live. Intended as informal hearings to allow expression of views, media coverage brought the issues of the north to the consciousness of the southern population as never before.

Community hearings were held by the Commissioner in 28 cities, towns, villages, settlements and outposts in the north likely to be affected by a pipeline. People who testified were not cross-examined, and witnesses were encouraged to express their personal views. So as to give equal emphasis to the formal and community hearings, arrangements were made with the Canadian Broadcasting Corporation to provide radio summaries of evidence given at formal hearings in the seven languages spoken in the area, and community hearings were held concurrently with formal hearings.

The Commissioner also arranged for financial support from government sources for intervenor groups - half a million dollars was made available to environmental and other public interest groups, and more than $1 million to native groups to provide for independent expertise. Justice Berger also instructed his Commission Counsel to obtain any evidence that he deemed relevant to the Inquiry, and to publicly present arguments on terms and conditions for pipeline construction.

Shortly after the hearings began in March 1975, another consortium, Foothills Gas, entered the arena with plans for an alternative pipeline route, which resulted in each company having to defend its proposals against the criticism of the other. But more importantly, the design of the Inquiry brought together two divergent sets of perceptions, values and information. To the industrial interests, land claims were a matter of monetary compensation for rights of way, but to the Indians, ownership is vested in the tribe as an entity, involving not only those presently living but also past and future generations and other living creatures.

It soon appeared that the cumulative effect of development was likely to be overlooked because of the short-term incremental approach of industry, and it was in dealing with this issue that the "non-experts" exploded the conventional view that only

technical people should make decisions on technical matters. Their insights on natural phenomena, such as the vulnerability of the Beaufort Sea, sea bed ice scour and hunting and trapping practices, helped provide a comprehensive overview of the potential impacts of the project.

Expert evidence provided by the Commission Counsel, and subsequently substantiated by the National Research Council, disputed Arctic Gas' analysis of the understanding of the impact of frost-heave on a pipe laid in permafrost. It then became clear that this fundamental aspect of pipeline design was far from being understood.

The Commissioner presented his findings to the Government early in 1977. He pointed to serious gaps in the scientific and technical knowledge available for the effective evaluation of any such large scale technologically-innovative undertaking, and ended:

> "Without such a body of knowledge, the government will not be able to make an intelligent disposition of industry's proposals, now or in the future."

He concluded that no pipeline should ever be built from Prudhoe Bay west to the Mackenzie Delta owing to potentially severe environmental damage, and that the construction of a Mackenzie Valley pipeline, while environmentally feasible, should be delayed for ten years, in order to settle land claims, establish new socio-economic programmes and institutions and fill essential scientific and technological knowledge gaps.

The Inquiry opened a national policy debate on a problem that had first been conceived in narrow technical and economic terms, and the report led directly to approval by Parliament for a completely different route along the Alaska Highway. The report reveals a fundamental problem encountered whenever large scale and complex technical projects are to be assessed - the impossibility of trial runs. A review of the Inquiry in "Science" put it this way:

> "Problems, even failures, are demonstrable only when the entire system is in place; and the only people with the technical knowledge to evaluate it are its proponents, who are all the more likely to err because of their own vested interest and the lack of independent criticism."

The technological assessments undertaken in this Inquiry led to a satisfactory outcome - a different route to avoid the technical and social problems, albeit at higher cost. But we have to learn to apply the methodologies and the thinking to resolve some of the pressing problems that challenge us in other broad scale areas, such as the impacts inherent in the development of the new national industrial strategies that we need to put in place over the next decade. A strong industrial sector, a secure and continuing energy supply, a quality environment, continued resource productivity, and other such needs which are

now evident and will become more important during the 1980's, rest on an enlightened evaluation of advanced science and technology and its application to the development of resources. As we begin to focus on the new decade ahead, the commitment we make at this time will ensure that the skills and tools will be in place in the years to come and will determine the kind of development we want to meet our needs. Surely, Mr. Chairman, there is a vital rôle for CCMS to play here.

DENMARK DANEMARK

Mr. J. Hartnack

In Denmark there is wide acceptance in theory of the need to assess the long-range implications of the introduction of new technology. However, in practice there is still far to go. Studies have been made or are under way in one or another institution. But no systematic approach encompassing assessment of decision-making on a broad scale has yet been introduced.

What has been and is our main approach is the regulating by law (on environment, energy, etc.) and administrative directions within the framework of existing laws of certain activities often sectorwise, specifying certain limits to what may result from actions taken by the public as well as the private sector. It is probably that this approach could very well be supplemented by technological assessment processes which better would take into account the long-range social, environmental and other implications of a given decision. In fact, there are, aside from the studies being made, some tendencies towards introducing technological assessment.

Larger employee participation in decision-making has led to a greater attentiveness to the social implications of the introduction of new technology, especially regarding the employment implications.

Thoughts on environmental implications and implications on use of energy and other resources are gaining ground and in fact certain planned projects have been scrapped or only come to fruition after long drawn-out debates on all possible implications of the projects' introduction. Others are still being hotly debated with decisions being deferred. Rules concerning land-use have been in force for several years. These rules, which to a large degree are administered at the local city or county council level, have seemed to work reasonably satisfactorily.

The statements made so far in this room, and results of investigations of Danish experience have led this Delegation to conclude that this Round Table discussion is timely and should hopefully help promote through the inspiration of this debate the further elaboration of T.A. as a tool of analysis and as a way of thinking for decision-makers. We would welcome increased international cooperation in the further elaboration of the concept of T.A.

PART II

SUMMARY OF DISCUSSION

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PARTIE II

RESUME DES DISCUSSIONS

SUMMARY OF DISCUSSIONS

The CHAIRMAN opened the discussion by remarking that any examination of technology assessments and environmental impact assessments led into the increasingly sophisticated area of the economics of risk management. This in turn demanded an attempt to define more precisely some of the quantitative criteria under which such assessments were carried out.

Mr. PLOTKIN (United States) said he would first deal with the questions posed by The Netherlands. With regard to the question whether technology assessment, as defined in the U.S., was similar to environmental impact assessments, in the ideal, an environmental impact assessment would be very similar to a T.A. The U.S. legal requirements for an environmental impact assessment resembled the objectives at least of T.A. In terms of the requirements for methodology in the U.S. regulatory system, however, there was really no similarity. There were few specific requirements for environmental impact statements methodology, whereas there were at least a number of methodological tools that T.As were expected to use, at least in the sense of having a very interactive system of bringing the public into discussions.

Turning to other aspects of the discussion, he said he had been struck by the range of opinion about how much technology assessment should be carried out. Mr. Rowcliffe had said something to the effect of "only when necessary". He would point to three factors worthy of consideration in trying to decide how much technology assessment was necessary. First, if it was decided to conduct T.A. on an ad hoc basis, the function of technology assessment as an early warning system would be lost. Secondly, he thought the public would demand technology assessment and whether it was thought it should be done or not, the pressure to do so would be heavy. Thirdly, governments would increasingly see public interest groups continuing their own technology assessments. Such assessments would not be truly objective, but if they were the only studies available, and if government was not prepared to counter them with its own study or a study sponsored by a reputed group, then difficulties were likely to arise.

The second issue was the question of whether T.A. should be performed by industry, government or outside organizations. The U.K. view appeared to be that industry should do it. The U.S. position, at least as stated at the meeting, certainly was in the direction of governments conducting a good deal of technology assessment although he agreed strongly with the U.K. Representative that industry must play a major role. He thought it safe to say with Dr. Hartkopf that probably they ought to have both.

It should be noted that the U.S. Government situation might be significantly different from the situation in Europe. The Office of Technology Assessment did not suffer from a great deal of pressure from Congress. This might simply be because of the structure of the government and the fragmentation of

interests within it. It might be because under the present party system in the United States, they did not have an entire party moving in the direction of promoting technology. In any event, T.A. in the United States had been able to operate without undue pressure. The situation might be very different in Europe.

Dr. LEITTERSTORF had questioned whether the advocates of technology assessment were really estimating the necessity of forecasting and were not pushing the idea of an assessment too hard. In an advocacy situation, there were those who, at the extreme, would present an idea like that of technology assessment as an infinitely superior methodology or tool. But he thought it safe to say that most advocates of technology assessment fully understood the uncertainty inherent in forecasting, and he believed that there were many assessments now under way which were attempting to take the uncertainty into account. Even accepting this uncertainty, technology assessment could not with certainty forecast the future. But they were faced with a future where any technology could have, theoretically, an infinite number of impacts and if they wanted to monitor those impacts they must decide which were the most severe. If nothing else, technology assessment allowed them to narrow the focus. Without that focus they could not hope to successfully control technology because the costs of monitoring were extremely high.

The CHAIRMAN said he would like to point out briefly that, under the auspices of the Science Committee, a certain amount of attention had been given to a variety of problems concerned with the management of technology. For example, there had been an Advanced Research Institute in 1976 dealing with Earth Observation Systems for Resource Management and Environmental Control that dealt with remote sensing from various sources. There had been an Advanced Research Institute in 1976 dealing with Earth Observation Systems for Resource Management and Environmental Control that dealt with remote sensing from various sources. There had also been a conference in 1977 on evaluating telecommunications systems and in 1979 a Research Institute dealing with the System Science Application and Energy Policy Planning. This year, there would be a conference in Germany on Man Systems Design. In 1981, a conference was proposed on Work Organization and Technological Change. Also under consideration was a Research Institute on the Use of Micro-Electronics in the area of office automation.

Under the Science Committee's Advanced Study Institutes Programme, there had been, in 1978, one dealing with Advanced Technical Biology and Applications in Advanced Health Care and another on Safety and Reliability Studies and Risk Assessment. One in 1979 had dealt with Lasers in Biology and Medicine.

Mr. COSTLE (United States) recalled that in his remarks at the 10th Anniversary Plenary Session, the United States had proposed that the CCMS begin an exchange of views on the management of technology in modern society. That suggestion had grown out of what the United States perceived as the evaluation of the Committee's role over its first decade of existence. On the one hand, they saw a common thread running through most of the Committee's efforts, whether it had to do with mitigating damage to the environment or solving other

questions such as societal concerns like safer roads, better health care and more secure forms of energy. That thread was the application of technology to serve socially beneficial needs. On the other hand, they felt that the decisions about specific subjects for the Committee to address had not all been taken within the context of a philosophical framework and that such a framework could be useful in adding a coherent direction to the work of CCMS given the Committee's history. The United States had suggested at that time that managing technology for society's benefit would be appropriate as an animated theme for future activities. Listening to the present discussion, he had been more confident than ever that they were basically on the right track. The United States welcomed the suggestion of Germany to hold a symposium on technology assessment. They regarded this as a logical first step following their suggestion of a conference at the 10th Anniversary Plenary. Such a symposium could bring together a small group of experts in various aspects of technological change, technological assessment and technological management. These experts could, through their discussions, identify future directions for the Committee as well as providing a philosophical and constitutional framework within which the Committee could operate. They would, of course, welcome suggestions from all member nations on the format of such a conference. In any event, the U.S. suggested that the conference be held in Europe in the spring of 1981. They must be realistic in their expectations of such a conference. Only by investing the very best in resources in such a conference would there be any assurance that the insights developed by the experts could be reliable in guiding CCMS activities in the next decade.

Mr. de SOUSA (Portugal) said discussion so far had centred round the question of how to make technology assessments. What was equally important was the determination of the benefits or inconveniences of technological development. It was not sufficient to know how to assess the impact of a technology. They must also know how to use the result. This must be a contiuing process. People were required who were able to think in terms of the quality of life at the end of the century and produce optional scenarios for decision-makers to choose from. One topic for the symposium suggested by Germany might be the strategy required to pursue this aspect.

Mr. KUPFER (Germany) suggested that the symposium proposed by the Federal Republic should be prepared by a meeting of experts who might come together either in July or in early September 1980.

Mr. COSTLE (United States) could support the German time-table.

Mr. KAKABEKE (Netherlands) agreed that a preparatory meeting of experts would be necessary. At the same time, it was important to determine the terms of reference for such a symposium. Some policy guidelines were required.

Mr. COSTLE (United States) thought that a helpful suggestion. He accordingly felt that an expert group might be convened during the summer to draft suggestions for the scope and frame of reference of the symposium which could be submitted to the Fall Plenary.

Mr. BEAULIEU (Canada) agreed. He wished further to point out that while there might often be a tendency to think of technological assessment as a means of regulating or controlling the process, there was a positive side to the matter which should not be lost sight of.

The CHAIRMAN thought that all the considerations mentioned might be taken into account in the preparation of a symposium. The Committee noted the proposal by the United States that a symposium or conference be organized under CCMS auspices in 1981 as a follow-up to the 10th Anniversary Conference as well as the present Round Table discussion. The presentations and discussions during the Round Table would be considered as preparatory in the organization of such a symposium. An expert group would be convened in time to prepare proposals for the Fall Plenary, preferably in July or early September. He would ask the United States, in consultation with other delegations, to convene this meeting, possibly in Brussels if that was convenient. It was generally understood that this would be the first stage of a continuing process in examining the general area of the management of technology. If these ideas were agreed by the Committee, he suggested they move on to their next agenda item.

RESUME DES DISCUSSIONS

Ouvrant le débat, le PRESIDENT fait observer que tout examen du problème des évaluations technologiques ou des évaluations d'impact sur l'environnement débouche sur le domaine de plus en plus complexe de l'économie de la gestion des risques, d'où la nécessité de chercher à préciser certains des critères quantitatifs sur lesquels se fondent ces évaluations.

M. PLOTKIN (Etats-Unis) indique qu'il commencera par traiter les questions soulevées par les Pays-Bas. Pour ce qui est de la similitude entre l'évaluation technologique, suivant la définition américaine, et l'évaluation d'impact sur l'environnement, il lui semble que, dans l'absolu, ces deux évaluations sont fort proches l'une de l'autre. Les prescriptions de la réglementation américaine concernant les évaluations d'impact s'apparentent aux objectifs - au moins - de l'évaluation technologique. Mais, sur le plan de la méthodologie prévue par cette réglementation, il n'existe en fait aucune similitude. Seuls quelques points de méthodologie sont spécifiés pour les études d'impact, alors que l'utilisation d'un certain nombre d'éléments méthodologiques est prévue dans le cas des évaluations technologiques, afin de promouvoir un système de concertation très poussée tendant à associer la population au débat.

Passant à d'autres points de la discussion, M. Plotkin déclare avoir été frappé par la diversité des opinions qui ont été exprimées sur la fréquence souhaitable des évaluations technologiques. M. Rowcliffe a estimé, en substance, que ces évaluations doivent être faites "seulement lorsque c'est nécessaire". M. Plotkin souhaiterait quant à lui invoquer trois considérations qui méritent d'être examinées si l'on veut déterminer la fréquence souhaitable des évaluations technologiques. Premièrement, si l'on décide de faire de telles évaluations sur une base ad hoc, elles ne permettront plus d'avertir d'un danger lointain. Deuxièmement, M. Plotkin pense que la population exigerait que les autorités procèdent à des évaluations technologiques et qu'une forte pression s'exercerait dans ce sens, que l'évaluation soit jugée utile ou non. Troisièmement, les gouvernements verraient de plus en plus souvent des associations réaliser leurs propres évaluations technologiques. Celles-ci ne seraient pas parfaitement objectives, mais si elles constituaient les seules études disponibles et si le gouvernement n'était pas en mesure de leur opposer ses propres études ou des études menées sous l'égide d'institutions réputées, il faudrait s'attendre à des difficultés.

Le second problème consiste à savoir si une évaluation technologique doit être établie par l'industrie, par les pouvoirs publics ou par des organisations extérieures. Le Royaume-Uni estime apparemment qu'elle devrait être confiée à l'industrie. Il est bien certain que les Etats-Unis, du moins selon leur position définie à la réunion, sont partisans de confier une grande partie des évaluations technologiques aux pouvoirs publics, encore que M. Plotkin soit tout à fait d'accord avec le représentant du Royaume-Uni pour considérer que l'industrie doit jouer un rôle majeur. Il lui semble néanmoins prudent de dire, comme M. Hartkopf, que les deux parties devraient sans doute être associées aux travaux.

Il est à noter que la situation se présente peut-être de façon très différente pour le gouvernement des Etats-Unis et pour ceux des pays européens. L'"Office of Technology Assessment" n'a pas subi de fortes pressions de la part du Congrès américain, ce qui tient peut-être simplement à la structure de l'exécutif et à la fragmentation des intérêts à ce niveau. Il est possible qu'en raison du système actuel des partis, aucun d'eux ne soit unanimement favorable au développement de la technologie. Toujours est-il qu'aux Etats-Unis, le système d'évaluation technologique a pu fonctionner sans s'exposer à des pressions excessives, ce qui n'est peut-être pas le cas en Europe.

M. LEITTERSTORF s'est demandé si les partisans de l'évaluation technologique tenaient vraiment compte de la nécessité de faire des prévisions et s'ils ne mettaient pas trop d'ardeur à promouvoir leurs thèses. Lorsqu'il s'agit de défendre leur cause, certains vont en effet jusqu'à présenter l'évaluation technologique, par exemple, comme une méthodologie ou comme un instrument infiniment supérieur à tous les autres. Il ne doute pas pourtant que la plupart des partisans de l'évaluation technologique reconnaissent le caractère intrinsèquement aléatoire des prévisions, et il croit que dans un grand nombre d'évaluations en cours, on cherche précisément à tenir compte de cet élément d'incertitude. Même dans ces conditions, l'évaluation technologique n'est pas un moyen infaillible de prévoir l'avenir. A terme, toute technologie peut théoriquement avoir un nombre incalculable d'impacts ; si l'on veut contrôler ces impacts, il faut en déterminer les plus graves. L'évaluation technologique permet du moins de mieux les cerner. Si elle ne le permettait pas, il serait inutile d'espérer contrôler la technologie car les coûts sont extrêmement élevés.

Le PRESIDENT souhaiterait brièvement rappeler que, sous les auspices du Comité scientifique, une certaine attention a été consacrée à divers problèmes liés à la gestion de la technologie. C'est ainsi qu'en 1976 a été organisé un séminaire de recherche avancée sur le thème de "Earth Observation Systems for Ressource Management and Environmental Control" concernant divers moyens de télédétection. Par ailleurs, en 1977, une conférence a porté sur l'évaluation des systèmes de télécommunications et en 1979, un séminaire de recherche a traité de "System Science Application and Energy Policy Planning". Cette année se tiendra en Allemagne une conférence sur le "Manned Systems Design". Pour 1981, il est proposé d'organiser une conférence au sujet de "Work Organization and Technological Change". On envisage également un séminaire de recherche ayant pour thème "Use of Micro-Electronics in the Area of Office Automation".

Dans le cadre du programme de cours d'été du Comité scientifique, un cours a été consacré en 1978 aux "Advanced Technical Biology and Applications in Advanced Health Care" et un autre aux "Safety and Reliability Studies and Risk Assessment". En 1979, un cours d'été a traité des "Lasers in Biology and Medecine".

M. COSTLE (Etats-Unis) rappelle que dans les commentaires qu'il a formulés à l'occasion de la session plénière du 10ème anniversaire, il a proposé que le CDSM entame un échange de vues sur la gestion de la technologie dans la société moderne. Les Etats-Unis ont avancé cette proposition en tenant compte du rôle que, selon eux, le Comité

avait joué au cours de ses dix premières années d'existence. D'une part, ils discernent un même fil conducteur dans la plupart des efforts du Comité, que ceux-ci portent sur la lutte contre les dommages causés à l'environnement ou sur le règlement d'autres questions telles que les grands problèmes de société (renforcement de la sécurité routière, amélioration des soins de santé, formes d'énergie plus sûres, etc.). Ce fil conducteur est l'utilisation de la technologie au bénéfice de la société. Mais d'autre part, les Etats-Unis ont l'impression que les décisions concernant les sujets spécifiques soumis au Comité n'ont pas toujours été prises en fonction d'un ensemble de principes déterminés qui pourrait aider le CDSM à donner une orientation cohérente à ses travaux, compte tenu de ceux qu'il a réalisés jusqu'à présent. Les Etats-Unis ont indiqué à cette occasion que la gestion de la technologie au bénéfice de la société constituerait à leur sens un thème fécond pour les activités futures. Les interventions qu'il vient d'entendre le confirment dans le sentiment que le Comité est sur la bonne voie. Les Etats-Unis accueillent favorablement la suggestion de l'Allemagne d'organiser un colloque sur l'évaluation technologique. Ils y voient la première suite logique de la proposition de conférence qu'ils ont faite à la session plénière du 10ème anniversaire. Ce colloque pourrait réunir un petit groupe d'experts s'intéressant aux divers aspects de l'évolution, de l'évaluation et de la gestion technologique. Ces experts pourraient, par leurs discussions, déterminer des orientations futures pour le Comité et définir un ensemble de principes et un cadre institutionnel dont il pourrait se servir pour mener ses activités. Il va de soi que les Etats-Unis étudieront avec intérêt les suggestions de tous les autres pays membres concernant la forme de cette conférence. Ils proposent de toute façon qu'elle ait lieu en Europe au printemps 1981 et pensent qu'il faut en envisager les résultats avec réalisme. C'est uniquement en préparant la conférence avec le plus grand soin qu'on peut avoir une certitude quelconque de voir les experts émettre des idées susceptibles de guider utilement les activités du CDSM durant la prochaine décennie.

M. de SOUSA (Portugal) constate que jusqu'ici, la discussion a tourné autour des moyens de réaliser des évaluations technologiques. Il est tout aussi important de déterminer les avantages et les inconvénients du développement technologique. Il ne suffit pas de savoir comment évaluer l'impact d'une technologie. Il faut également savoir comment en utiliser les résultats. Il doit s'agir là d'un processus permanent. Il faut trouver des personnes capables d'imaginer ce que sera la qualité de la vie à la fin du siècle et de concevoir des scénarios parmi lesquels les décideurs pourront choisir. L'un des thèmes du colloque proposé par l'Allemagne pourrait être à employer dans ce domaine.

M. KUPFER (Allemagne) pense que le colloque proposé par son pays devrait être préparé au cours d'une réunion d'experts qui pourrait avoir lieu en juillet ou au début septembre 1980.

M. COSTLE (Etats-Unis) peut accepter les dates proposées par l'Allemagne.

M. KAKABEKE (Pays-Bas) convient qu'une réunion préparatoire au niveau des experts est nécessaire. Il importe en même temps de déterminer le mandat d'un tel colloque. Certaines orientations doivent être fixées.

M. COSTLE (Etats-Unis) estime cette suggestion utile. Il pense donc qu'un groupe d'experts pourrait se réunir au cours de l'été pour rédiger des suggestions touchant la portée et au mandat du colloque et que le Comité pourrait en être saisi à la session plénière d'automne.

M. BEAULIEU (Canada) marque son accord sur ce point. Il voudrait également faire remarquer que, si l'on tend souvent à voir dans l'évaluation technologique un moyen de régulation ou de contrôle du processus, elle présente aussi un côté positif qu'il ne faut pas perdre de vue.

Le PRESIDENT estime qu'il pourrait être tenu compte de toutes les considérations qui viennent d'être émises pour préparer le colloque. Le Comité prend note de la proposition des Etats-Unis visant à organiser en 1981, sous les auspices du CDSM, un colloque ou une conférence faisant suite à la conférence du 10ème anniversaire et à la présente table ronde. Les exposés et les débats de ce jour seront considérés comme des préliminaires à l'organisation de ce colloque. Un groupe d'experts se réunira en temps voulu - de préférence en juillet ou au début septembre - pour préparer des dispositions destinées à la session plénière d'automne. Il souhaiterait inviter les Etats-Unis, en consultation avec d'autres délégations, à se charger de convoquer cette réunion, peut-être à Bruxelles si cela convient à tous les intéressés. Il est généralement admis qu'il s'agira là de la première étape d'un processus permanent consacré à l'examen du problème général de la gestion de la technologie. Le Président suggère, si ces idées sont approuvées par le Comité, de passer au point suivant de l'ordre du jour.

APPENDIX

BACKGROUND PAPER

Perspectives on the Use of Technology Assessment in the United States

Prepared by Steven E. Plotkin

Office of Technology Assessment - U.S. Congress

Washington, D.C. 20510

U.S. Round Table Discussion Paper

CCMS Spring Plenary 1980

Perspectives on the Use of Technology Assessment in the United States

I. INTRODUCTION

Every major new technology arrives on the scene heralded by claims that it will benefit mankind. Yet, in virtually every case, the introduction of this technology produces unintended consequences that often have reduced, and in a few cases even negated, the benefits that were claimed. To cite a well-known example, the automobile increased mobility and eliminated the odors and health problems associated with the horse-drawn transportation it replaced. However, it also has led to massive air pollution, tens of thousands of deaths yearly through accidents, and radical changes in entertainment habits, social patterns, urban and suburban land use, and economic structures.

Agricultural technology also has its share of developments which caused major unintended consequences. One instance is the introduction of pesticides which, by persisting in the environment and reconcentrating in human, animal and plant tissues, caused subsequent health and ecological damage. Mechanical harvesting of crops created unemployment in rural communities and massive migration to cities. High-yield grains produced by advances in plant genetics gave birth to the "Green Revolution," but also imposed on developing countries more capital and energy-intensive systems of agriculture which in turn exposed them to severe strains due to rising oil prices. The accompanying reduction in species diversity also created greater vulnerability to variations in weather and reduced resistance to diseases and pests, raising the possibility of catastrophic crop failures.

The historical pattern in such cases has been for governments, given enough public pressure, to react by taking steps to mitigate the effects after the fact. A substantial portion of U.S. laws and regulatory activity concerns controlling the adverse impacts of technology. This activity began in 1852 with the passage of a law creating a federal agency to inspect and regulate steamboat boilers. This legislation came as a result of decades of public outcry over the casualties caused by explosions in boilers which had been improperly constructed or maintained. Subsequently, the federal government has assumed responsibility for protecting the public from many technical applications ranging from mining to aviation. A basic characteristic of virtually all of these efforts, unfortunately, is that they were enacted in response to problems that came to light only after the technologies were already thoroughly diffused throughout society. Thus they could treat the symptoms but not cure the underlying problem.

The increased public scepticism about the advantages of new technologies as expressed through the environmental and consumer movements of the 1960s and 1970s in the United States, has resulted in the view that government and industry must do better than simply responding after the damage is done. It is now being recognized that the parties involved must make greater efforts to anticipate adverse side effects and forestall them by modifying the technology before its introduction or, if necessary, ban its spread entirely.

This recognition has spurred efforts by governmental bodies to develop analytical tools, both quantitative and qualitative, to assist in forecasting possible adverse side effects. The combination of these tools into a coherent framework for analyzing technology impacts is often referred to as Technology Assessment, or TA. Originally thought of as an early warning system for adverse effects, TA has tended to evolve into a more neutral and analytical tool which views the impacts as either positive or negative. In other words, besides warning of adverse effects and examining ways of mitigating them, a TA should also identify unforeseen benefits and suggests means of overcoming constraints on the spread of the technology if this proves to be desirable.

II. METHODS AND GOALS OF TECHNOLOGY ASSESSMENT

Although there is no universally accepted definition of TA, one that is likely to be acceptable to many practitioners is:

> "TA is a class of policy-oriented research aimed at the anticipation, identification, and evaluation of the potential impacts or consequences of a technology (or project) on society, on a region, or on a community. TA must consider secondary (unplanned or derivative) impacts and consequences - that is, (it) must go beyond questions of technical feasibility, direct or internalized costs, and safety considerations." 1/

Unfortunately, like most definitions of TA this describes what a TA hopes to accomplish but fails to specify how it will be done. In other words, the definitions are oriented toward the goals of TA rather than to the methods. This partially reflects great disagreement in the field about the proper procedure for conducting a proper TA.

However, there is some convergence in opinion about certain critical aspects of TA. Thus, the majority of practitioners would probably agree on the following points:

(1) TA requires a team effort. Individual team members must possess a broad range of skills.

(2) A TA team is interdisciplinary as well as multidisciplinary. In other words, rather than working in isolation, individual team members interact extensively with their fellow members, reviewing and criticizing their work and modifying their own work in response to what their fellows are doing.

(3) TA must use a consistent set of assumptions for all its component analyses. This requires that all economic, environmental, and technical analyses use the same assumptions, data bases, and future scenarios. A set of individual, uncoordinated studies cannot be simply aggregated to yield a TA.

There have been many attempts to codify the TA "process" by specifying the steps that all TAs should follow. The ten modules described by Joseph Coates 2/ for example, is a well-known and intelligent effort, although not necessarily a widely accepted one. Several of his steps, however, illuminate the policy-oriented character of TA and are worth restating:

- o define with precision the parties at interest who will be affected by, or who will affect, the new technology
- o define the roles and responsibilities of decision-makers who may affect solutions to various problems
- o examine the effects of changes in some of the implicit assumptions - such as the state of world peace, or basic economic conditions - that underlie the TA analysis.

Beyond this, the scope and method of a given TA depends upon individual situations.

III. WHO PERFORMS TA IN THE UNITED STATES AND WHAT ARE THEIR CAPABILITIES?

A wide variety of government, business, and public interest organizations in the United States perform analyses having at least some of the attributes of TA. In the public sector two organizations the National Science Foundation and the Office of Technology Assessment - practice and support TA to the greatest extent for their respective branches of government.

The Office of Technology Assessment (OTA) is a staff agency of the United States Congress. It assists Congress to explore complex issues involving science and technology and to clarify the range of policy options for resolving these issues and the potential impacts of adopting each of these options. OTA also provides the legislative branch with an analytical capability that is independent of the executive branch agencies which may have vested interests that limit their objectivity.

OTA conducts assessments in response to requests from House and Senat Committee chairmen and members of its 12-member, bipartisan Congressional Board. The bulk of OTA's work involves comprehensive assessments that may require a year or more to complete, although it also provides shorter-term analyses for more urgent needs. Each of the assessments is conducted by multidisciplinary project teams drawn from OTA's permanent staff of 80 to 90 professionals, supplemented by consultants and contractors. Each assessment also draws support from an advisory

panel composed of scientific experts as well as directly affected groups from labor, industry, the academic community, public interest groups, state and local government, and the citizenry at large. These panels help to define and shape the course of OTA studies, as well as to review the findings before they are released. OTA also conducts workshops and public hearings to solicit further review of its work.

The National Science Foundation (NSF), the leading supporter of TA in the executive branch agencies, has a mission that can perhaps best be stated as the promotion of American science. Although it has no direct regulatory responsibilities, NSF performs TAs on a wide range of issues. It also carries out studies investigating the theory and methodology of TA. As of 1977, NSF's Research Applied to National Needs (RANN) program had sponsored over 40 TAs as well as several methods studies and conferences at a cost of over $10 million.3/ Unlike OTA, NSF does not conduct assessments using its own employees but instead contracts with universities, private industry, and individual consultants to perform them.

Aside from NSF, a variety of other executive agencies have various forms of TA programs. The U.S. Environmental Protection Agency (EPA), for example, created an "Integrated Assessment Program" in 1975 to conduct TAs of large energy systems. Several of the assessments carried out by this program are very large, with individual budgets exceeding $1 million. EPA has completed or is continuing assessments of energy development in the western United States, the Ohio River Basin, and the Texas lignite fields, as well as an assessment of future development of the fossil-fueled sector of the electric utility industry. All of these TAs are conducted using contract research, with EPA's personnel acting as research managers rather than directly in an analytical capacity. However, EPA has recently begun to build some in-house TA capability in its Office of Research and Development.

The U.S. Department of Energy (DOE) has a similar program in its Office of Environment. Although some of this work is contracted to private industry, a considerable portion of the program is conducted by the National Laboratories (Oak Ridge, Argonne, Pacific-Northwest, Brookhaven, etc.). Although the National Laboratories are not solely responsible to DOE, the Department maintains a stable, long-term financial relationship with the Laboratories that allows them to serve in a capacity similar to in-house staff. The major effort by the "team" of National Laboratories is a multiyear study of future coal development in the United States called the National Coal Utilization Assessment. However, because of the difficulties in coordinating the activities of the individual National Laboratories, the capability to produce an integrated TA is still evolving.

A 1972 review of TA activities identified over 60 offices performing or sponsoring TAs. 4/ Some examples are:

- The Agricultural Research Service and Economic Research Service of the U.S. Department of Agriculture (USDA) conducts assessments of advances in agricultural technology.

- The National Center for Health Statistics Research assesses innovations in health research and technology.

- The U.S. Department of Transportation (DOT) has made assessments of automated guideway transit, pipelines, and diagnostic motor vehicle inspection systems.

- The Department of Housing and Urban Development (HUD) has made assessments of local systems for providing heat and electricity to small communities, apartment houses, etc., and residential energy conservation techniques.

Both the private sector and the academic community also conduct a wide range of technology assessment activities, both in relation to government actions and independent of them. Large private industrial firms including Monsanto, Coca-Cola, Ford Motor Company, Southern California Edison Company, Bell Laboratories, and Systems Development Corporation use TA in their corporate planning.5/ Other research firms, such as SRI International and the Futures Group, perform TAs in support of both private and governmental clients. Many U.S. universities teach college courses in TA and some, such as the University of Oklahoma's Science and Public Policy Program have instituted full-fledged TA programs that are independent of their academic departments. Oklahoma's program for example, has a staff composed of researchers holding joint positions as fellows in the TA program and as instructors or professors in the academic departments.

IV. HOW TA HAS BEEN INCORPORATED IN U.S. DECISION-MAKING

It is usually very difficult to prove that any analytical assessment has been primarily responsible for influencing public or private decision-making. This is especially true when the issues at stake are complex and when there is heated contention about their resolution. For example, a review of some early TAs identified several actual decision outcomes (including the blocking of an airport project, new controls on logging practices, and establishment of a new agency) that appeared to follow recommendations by the TAs, but the author was careful to disassociate himself from any claims of cause and effect.6/ Usually a reasonable argument can be made that the outcomes would have occurred anyway.

Despite these difficulties, however, it is possible to develop a picture of TA's influence in U.S. decision-making as long as care is used in interpreting the available evidence. The significance of a TA's role in such decision-making is indicated by the following:

- The TA is assigned a well-defined role in the formal decision-making process.
- Insights developed by the TA clearly have an effect on public or private discussion of issues.
- Recommendations or policy options presented by the TA are adopted.
- Team members are subsequently given positions of authority over the technologies they have assessed or are given some other opportunity to influence the technology, primarily as a result of their work on the TA.

Although many U.S. government agencies conduct TAs, the only case where such an assessment is mandated by law as part of the formal decision-making process is the National Environmental Policy Act of 1969. This requires that each federal agency must:

> "... include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on:
> (i) the environmental impact of the proposed action,
> (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
> (iii) alternatives to the proposed action,
> (iv) the relationship between local short-term use of man's environment and the maintenance and enhancement of long-term productivity, and
> (v) any irreversible and irretrievable commitments of resources which would be involved if the proposed action should be implemented."

These required "Environmental Impact Statements," or EISs, may resemble TAs in that they are expected to explore secondary as well as primary impacts and are expected to identify social and economic as well as environmental effects. In practice, however, many EISs have been restricted in their exploration of effects beyond direct pollution effects and have undertaken only limited analyses of alternative policy options for mitigating adverse impacts. On the other hand, the requirement to do EISs has

> "created a general demand through the Federal system for the systematic exploration of the secondary impacts of projects, and a consequent demand for the development of methodologies, techniques, approaches, and protocol." [7]

Although NEPA does not mandate that agencies must respond to findings of adverse consequences by taking mitigative action, such findings may force compromises or even abandonment of poorly

conceived projects. Officials in the U.S. Environmental Protection Agency feel that there are numerous examples of important project changes that can clearly be traced to the surfacing of unforeseen impacts and design alternatives by the EIS process.

Congressional hearings represent an additional mechanism whereby the results of TAs and ther analytical studies have a clear opportunity to influence decision-making, in this case the decision-making of the federal government's legislative branch. The TAs conducted by the Office of Technology Assessment provide the most straightforward example of this mechanism since most OTA assessments are sponsored by House and Senate Committees which normally hold hearings on the subjects of the assessments when they are completed. Aside from these initial hearings, OTA assessment teams generally are called to testify at any subsequent hearings concerning the technologies in question. Because a portion of each assessment team is composed of OTA permanent staffers, the ability to respond to Congressional needs normally remains with the Agency for a year or more after study completion. The insights gained can be reflected in modifications or refinements of legislation prior to enactment.

A particularly good example of how a TA may affect the U.S. decision-making process is illustrated by "Energy Under the Oceans", a TA of outer-continental shelf oil and gas operations conducted by the University of Oklahoma's Science and Public Policy Program. The 1978 amendments to the Outer Continental Shelf Lands Act adopted some of the critical recommendations of the "Energy Under the Oceans" study, including requirements for Best Available and Safest Technology for offshore operations, and an expansion of the range of leasing alternatives. Also, both the U.S. Geological Survey and the Bureau of Land Management adopted a number of the Study's recommendations. These measures included the establishment of an Offshore Advisory Committee to expand the participation of outside interest groups in the review of proposed regulations, changes in the requirements for baseline data collection and monitoring, adoption of requirements for a systems engineering approach to component design, a longer-term development schedule, and the inclusion of the National Oceanographic and Atmospheric Administration (NOAA) in Outer Continental Shelf analyses.

The key to the influence of this TA appears to be the very substantial effort on the part of the TA team, beginning early in the assessment, to interest and inform critical policy groups, including key congressional committee staff members.

V. INSIGHTS GAINED BY THE U.S. IN THE APPLICATION OF TA

Even after well over a decade of experience and the completion of hundreds of assessments, TA is not an exact science. This section will briefly highlight some of the problems and unresolved issues of TA.

A. Use of Quantitative Methods

Making the decision about whether or not to introduce a new technology would be vastly simplified if all the impacts could be reduced to a numerical summation of costs and benefits. However, this is never possible, and every TA represents a balance between qualitative analysis and subjective judgment.

An overemphasis on quantitative methods can mean that much of the effort of the TA is diverted to manipulating whatever data is available and constructing elaborate mathematical models. In the process, the insights into unintended consequences that can only be obtained from human intuition and experience may be neglected. Conversely, placing too much emphasis on expert opinion may not provide a systematic evaluation of all the impacts. Moreover, the debate over the results may have a tendency to be ad hominem rather than ad rem.

The balance between quantitative and qualitative methods has to be adjusted to the individual circumstances of each TA. It depends upon the nature of the technology being assessed, the resources and time available, and the audience for which the results are intended.

Much research and development remains to be done in the quantification of information. For example, several techniques, such as the Delphi method, are being investigated for weighing expert opinions. Also the modelling of environmental, economic, and social effects on a comprehensive and integrated basis is still in a preliminary stage.

B. Expectations for TA

In some cases, a TA may have been viewed as a failure by some groups because it did not resolve a major confrontation over the development of a technology. This arises because of a view that TA serves as a kind of science court which finds a technology innocent or guilty of unpermissible adverse impacts. Aside from the methodological problems of reaching such a conclusion, it should be recognized that TA is never assigned this role. Generally, it can only serve to clarify the issues for the actual decision-makers in the executive and legislative branches of government.

Moreover, a TA can provide many useful functions short of rendering a final verdict on a technology. It can indicate modifications to avert impacts, or suggest alternatives which may be more beneficial. In some cases, a TA has been most valuable in creating a pool of experts from which may be drawn the personnel to lead programs to regulate the technology.8/

C. The Nature of the TA Team

A successful TA demands interactive, self-critical analysis wherein each team member must assume the responsibility for critically reviewing and challenging his fellow team members' assumptions, data choices, and methodology. It is this interactive review that makes a team interdisciplinary rather than merely multidisciplinary. In addition, TAs are usually so broad in their scope that the individual team members are always straining against the boundaries of their disciplines and must seek help from other sources to ensure analytical accuracy. Unfortunately, scientists and engineers in hierarchical organizations generally are extremely sensitive about peer criticism, and are doubly so when the criticism comes from those outside their discipline. The result of this basic antagonism between the TA model and the "normal" scientific model is that the majority of experienced scientists and engineers have considerable difficulty in working effectively as TA team members.

In addition, an expert taking part in a TA will inevitably spend a significant amount of his time gaining a general knowledge of other fields at the expense of further pursuing his own specialty. This can be perceived as detrimental to career advancement.9/

There is no easy solution to this problem. The U.S. Office of Technology Assessment avoids the issue by establishing a totally separate TA organization, but it runs the risk of losing some of the advantages in scientific rigor that may be gained by maintaining both disciplinary and TA analysis within the same organization. In such separate organizations where analysts work essentially full-time on TA-type projects, it may be important to ensure a continual infusion of new talent.

D. Inclusion of Interest Groups in the TA

A comprehensive TA must take into account the views and concerns of all parties who may be affected by the introduction of a new technology. Both the actual objectivity of the analyses and their perceived objectives may be enhanced by allowing members of these groups to participate in all stages of the assessment. OTA, for example, routinely includes such members in their advisory panels, and these panels help to plan the TA as well as review the impact and policy analyses and final reports. However, to successfully include such people usually means translating all of the study's assumptions, methodological descriptions, and conclusions into language suitable for a layman. Expert members will also be exposed to criticism and review while still in the process of studying the information and forming opinions. However, if done properly, this will serve to enhance the internal communication among team members and to create a more truly interdisciplinary product.

E. Credibility of TA

The ultimate purpose of a TA is to provide information for the public decision-making process. The usefulness of a TA will thus be limited if it is perceived to be biased, regardless of its actual objectivity, because of the organization which sponsored it or the composition of its members. For example, cost/benefit analyses of new projects by the Corps of Engineers or the Atomic Energy Commission and its successors have generally come to be regarded with suspicion because the sponsoring agency had a vested interest in the project going forward. Although steps for enhancing the perceived credibility of a TA may be taken, such as the use of extensive external review, these efforts may be overwhelmed by poor public perceptions of the performing or sponsoring organization. Thus, organizations with either regulatory or advocacy roles must be prepared to devote considerable time and effort to overcoming prejudice.

Consideration should be given to assigning TA responsibility either to an independent government agency such as OTA or to a university or respected research institution with a reputation for objectivity. The TA organization must be carefully insulated from special interests in a way that not only works well operationally but also is perceived as working well. In the case of OTA, this insulation is provided by its being housed in the legislative branch and by using a bipartisan governing board as a buffer between it and individual Congressional committees.

Because of differences between the U.S. system and that of other NATO nations, OTA's institutional arrangement may not be transferable.

Also affecting the credibility of a TA team is background of its members, especially the extent of specific experience with the technology being assessed and past association with interest groups concerned with the technology. This includes groups which are opposed to the introduction of a technology as well as those that are in favor of it. On the other hand, individuals with such close ties can provide to the assessment an important understanding of the nuances of a technology and of the interest groups it affects. However, they should be used as team members only when necessary to the team's fully understanding the technology, and the usual system of internal and external reviews must be applied with special diligence to their work. Finally, TA's critical need for actual and perceived objectivity demands that the project director not be such an individual.

VI. POSSIBLE ISSUES FOR ROUND TABLE DISCUSSION

1. To what extent is government, or industry, responsible for anticipating the adverse impacts of technology?

2. What are the relative roles of government and of industry in carrying out such responsibilities?

3. What criteria should be used to decide if government should favor technology with positive impacts by eliminating economic or non-technical barriers?

4. How should the benefits be weighed against the risks of a new technology?

5. What is the most useful role for technology assessment in the public decision-making process?

6. How can the concerns of local interested parties be included in the assessment, as well as the public at large and the international community?

7. How can the credibility and objectivity of a technical assessment be preserved while at the same time ensuring an adequate level of expert analysis?

FOOTNOTES

1. Coates, V.T., Statement before Subcommittee on Science Research and Technology, Committee on Science and Technology, U.S. House of Representatives, Review of the Technology Assessment Act (Committee Print No. 71), August 3, 1977.

2. See Coates, J.F., "Technology Assessment and Public Wisdom," J.Wash. Acad. Sci., Vol. 65, No. 1, 1975.

3. Coates, V.T., op cit.

4. Coates, Vary T., "Technology and Public Policy: The Process of Technology Assessment in the Federal Government." George Washington University Program of Policy Studies in Science and Technology (Washington, 1972).

5. Kranzberg, M., Statement before Subcommittee on Science, Research and Technology, Committee on Science and Technology, U.S. House of Representatives, Review of the Technology Assessment Act (Committee Print No. 71), August 3, 1977.

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8. An example is Don Kash, formerly Director of the Science and Public Policy Program, University of Oklahoma, now Chief, Conservation Division, U.S. Geological Survey.

9. For an excellent discussion of this point, see White, I.L, "Interdisciplinarity," in Perspectives on Technology Assessment, Arnstein, S.R. and A.N. Christakis, eds., Science and Technology Publishers, Jerusalem, 1975.